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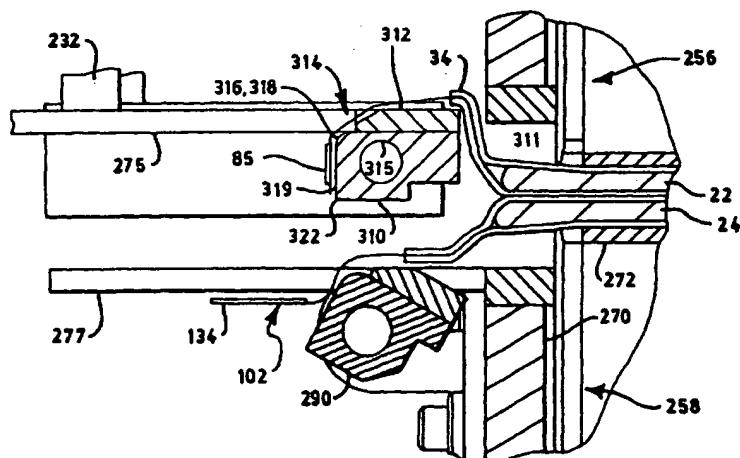
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(57) Abstract: A panel of a material is transported in operative proximity to an air knife having a nozzle and a curved Coanda surface, such that the panel is folded over the curved Coanda surface as the material is transported in a machine direction. The panel can be folded to a variety of angles and can comprise a fastenable component. Air knives are employed in various methods for folding garment side panels and forming prefastened garments, such as refastenable pants.

PRESENTATION AND BONDING OF GARMENT SIDE PANELS

Background of the Invention

The present invention pertains to processes and apparatus for handling material webs, and more particularly to processes and apparatus for making prefastened garments.

- Garments such as disposable absorbent garments have numerous applications including diapers, training pants, feminine care products, and adult incontinence products.
- 5 The typical disposable absorbent garment is formed as a composite structure including an absorbent assembly disposed between a liquid permeable bodyside liner and a liquid impermeable outer cover. These components can be combined with other materials and features such as elastic materials and containment structures to form a product that is specifically suited to its intended purposes.
- 10 Manufacturing techniques for making conventional garments are in some respects inadequate for making new product forms, such as prefastened and refastenable garments. Hence, what is lacking and needed in the art are new processes and apparatus for handling material webs, and in particular in relation to making prefastened garments such as disposable absorbent pants.

15

Summary of the Invention

- In response to the above-referenced unfulfilled need in the art, new processes and apparatus for handling material webs and making prefastened garments have been discovered. One aspect of the present invention pertains to the use of an air knife for
- 20 material handling. The air knife can be used to position a material for bonding, fastening, or other purposes. The material can comprise any relatively flexible material, whether permeable or impermeable to fluids, such as woven materials, nonwoven materials, films, or the like. The air knife can be used to control and/or guide the position of materials comprising mechanical fastening components which tend to engage other materials which
- 25 they contact.

- Hence, in one embodiment, a method of folding a material includes transporting a material in a machine direction and transporting a panel of the material in operative proximity to an air knife. The air knife comprises a nozzle and a curved Coanda surface. Air is expelled from the nozzle such that the panel is folded over the curved Coanda surface as the material is transported in the machine direction.

30 Operation of the air knife creates an air sheet formed of the expelled air jet and entrained ambient air. The Coanda surface creates a pressure differential across the two

sides of the air sheet, forcing the air sheet to "attach" to and follow the Coanda surface. The panel, when transported in operative proximity to the air knife, is drawn to and carried on the air sheet. For purposes of the present application, a material or panel is considered in "operative proximity" to an air knife when the material or panel is spaced sufficiently 5 close to the air knife to have its path of travel impacted by operation of the air knife.

In the present methods, the Coanda surface is curved with respect to the nozzle flow direction, and the panel is carried or folded over the curved surface. For purposes of the present invention, a panel or portion of a material being "folded over a curved Coanda surface" means that the panel is drawn toward the curved surface and wraps over and 10 around the curved surface, supported by the cushion of air flowing over the curved surface. In other words, the panel is inwardly folded about an axis, where the curved Coanda surface is disposed between the axis and the panel. As the material and panel are transported in the machine direction, the panel can be folded from a generally planar position prior to the air knife to a fully folded position further downstream, such that the 15 angle or degree of the fold increases with movement in the machine direction. In particular embodiments, the panel can be folded through an angle of about 45 or greater, and more particularly about 90 degrees or greater. As discussed in greater detail below, the panel can comprise a refastenable fastening component, for example in relation to embodiments concerning refastenable garments.

20 Another aspect of the invention concerns a method of forming a prefastened pant. One embodiment of such method comprises transporting a stream of discrete, partially assembled and folded pants in a machine direction. Each pant comprises a first waist region with opposed first side panels and a second waist region with opposed second side panels. The method further comprises transporting the first side panels in operative 25 proximity to air knives, which comprise nozzles and curved Coanda surfaces. Air is expelled from the nozzles such that the first side panels are folded over the curved Coanda surfaces. The second side panels are folded into position transversely outward from the first side panels, and the respective first and second side panels are permanently or refastenably bonded together.

30 Another embodiment of the method of forming a prefastened pant comprises transporting a stream of discrete, partially assembled and folded pants in a machine direction, and transporting the first side panels in operative proximity to air knives. In this embodiment, each pant comprises a first waist region with opposed first side panels including first fastening components, and a second waist region with opposed second side 35 panels including second fastening components. The fastening components are capable of refastenably engaging one another. Each air knife comprises a nozzle and a Coanda

surface. Each Coanda surface defines a curved portion and a generally planar portion, where the curved portions are disposed between the nozzles and the generally planar portions. Air is expelled from the nozzles such that the first side panels are folded over the curved Coanda surfaces with the first fastening components disposed on the generally planar portions. The second side panels are moved into overlapping orientation with the first side panels, with the second fastening components positioned transversely outward from the first fastening components. The first and second fastening components are refastenably engaged.

To facilitate high speed formation of the refastenable pants, the air knives can be mounted in a cantilevered configuration, so that the refastenably engaged side panels are transported past the downstream ends of the air knives. In particular embodiments, air is expelled from the nozzles in a direction generally perpendicular to the machine direction. Various techniques can be used to move the second side panels into overlapping orientation with the first side panels. For example, a reciprocating panel folding head can intersect the path of travel of the second side panels. Air knives can also be used to position the second side panels.

A further aspect of the invention concerns an exhausted air knife. In one embodiment, the air knife comprises a plenum defining an internal chamber, a nozzle operatively connected to the internal chamber and defining a nozzle flow direction, and a Coanda surface adjacent and extending beyond the nozzle. The Coanda surface can be curved in cross section relative to the nozzle flow direction and can define a curvature of about 90 degrees or greater from the nozzle to a terminal edge. In this embodiment, the Coanda surface comprises first and second curved portions and first and second generally planar portions, where the first curved portion is disposed between the nozzle and the first generally planar portion and the second curved portion is disposed between the first and second generally planar portions. A flange is positioned in close proximity to the Coanda surface opposite the second generally planar portion and defines therebetween an exhaust passage.

Another embodiment of the exhausted air knife comprises a plenum defining an internal chamber, and a cap attached to the plenum. The cap comprises a first flange, a second flange and an intermediate member connecting the first and second flanges. The first flange is positioned in close proximity to the plenum and defines therebetween a nozzle that is in fluid communication with the internal chamber. The second flange is spaced from the plenum and defines therebetween an exhaust passage. The intermediate member defines at least one aperture in fluid communication with the exhaust passage. A Coanda surface is disposed adjacent and extends beyond the nozzle. The Coanda

surface is curved in cross section relative to the nozzle flow direction and defines a curvature of about 90 degrees or greater from the nozzle to a terminal edge.

In particular embodiments, the curvature of the Coanda surface can be about 90 to about 270 degrees, for example about 135 to about 225 degrees. The first and/or second 5 curved portions can in certain embodiments define angles of about 90 degrees or more.

A further aspect of the invention concerns an apparatus for folding a pair of garment side panels. In one embodiment, the apparatus comprises a transport system defining a machine direction and a machine center line, and a pair of air knives located on opposite sides of the machine center line at fixed locations in the machine direction. Each 10 air knife comprises a nozzle and a curved Coanda surface. In this embodiment, each air knife is aligned generally parallel to the machine center line such that the nozzle flow direction is generally perpendicular to the machine direction.

Another aspect of the invention concerns an apparatus for positioning pairs of garment side panels in an overlapping orientation. In one embodiment, the apparatus 15 comprises a transport system defining a machine direction and a machine center line, an interior panel positioning mechanism adapted to fold a first pair of side panels about an axis generally parallel to the machine direction, and an exterior panel positioning mechanism adapted to position a second pair of side panels transversely outward from the first pair of side panels. The interior panel positioning mechanism comprises air 20 knives, with each air knife comprising a nozzle and a curved Coanda surface.

The garments can include refastenable or non-refastenable side seams. Non-refastenable bonded seams can be formed by ultrasonic bonds, adhesive bonds, thermal bonds, sewing, or the like. Fastening components to form refastenable seams can comprise separate elements bonded to another component of the pant. Alternatively, the 25 fastening components can comprise a portion of another element of the pant, such as the bodyside liner, the outer cover, separate side panels if employed, integral side panels if employed, a belt-type component extending transversely across the chassis if employed, or the like. Thus, unless otherwise specified, the term "fastening component" includes separate components which function as fasteners and regions of materials such as side 30 panels, liners, outer covers or the like which function as fasteners. Moreover, a single material can define multiple fastening components to the extent that different regions of the material function as separate fasteners. The fastening components can be located on the side panels, between the side panels such as on the absorbent chassis, or a combination of the two. The fastening components can have any desired shape, such as 35 square, rectangular, round, curved, oval, irregularly shaped, or the like. Each fastening component can comprise a single fastening element or multiple fastening elements.

The fastening components can comprise any refastenable fasteners suitable for absorbent articles, such as adhesive fasteners, cohesive fasteners, mechanical fasteners, or the like. In particular embodiments the fastening components comprise mechanical fastening elements for improved performance. Suitable mechanical fastening elements 5 can be provided by interlocking geometric shaped materials, such as hooks, loops, bulbs, mushrooms, arrowheads, balls on stems, male and female mating components, buckles, snaps, or the like. In particular embodiments, the fastening components and mating fastening components comprise hook-and-loop fastening elements. One skilled in the art will recognize that the shape, density and polymer composition of the hooks and loops 10 may be selected to obtain the desired level of securement between the fastening components and the mating fastening components. A more aggressive hook material may comprise a material with a greater average hook height, a greater percentage of directionally-aligned hooks, or a more aggressive hook shape.

Refastenable fastening systems allow for easy inspection of the interior of the 15 pant-like product. If necessary, the fastening system also allows the pant to be removed quickly and easily. This is particularly beneficial when the pant contains messy excrement. For training pants, the caregiver can completely remove the pant-like product and replace it with a new one without having to remove the child's shoes and clothing.

The present invention can be used in the manufacture of a wide variety of 20 absorbent and non-absorbent products, including training pants, swim pants, diaper pants, incontinence garments, feminine care products, health care garments, apparel for institutional, industrial and consumer use, or other garments. Absorbent articles are adapted to be worn adjacent to the body of a wearer to absorb and contain various exudates discharged from the body. The absorbent articles can be prefastened to provide 25 a pant-like product for the user. The product can then be pulled on like a conventional training pant, and subsequently checked or removed with the ease of a diaper-like product. Moreover, the product may be applied like a diaper rather than like a pant. Supplemental releasable fastening means such as frangible point bonds may be employed to maintain the absorbent article in a pant configuration until the user 30 intentionally disengages the fasteners.

Particular training pants suitable for use with the present invention are disclosed in U.S. Patent Application Serial No. 09/444,083, filed on November 22, 1999 (corresponding to PCT application WO 00/37009 published June 29, 2000) by A. Fletcher et al. and titled "Absorbent Articles With Refastenable Side Seams;" which is 35 incorporated herein by reference. This reference describes various materials and methods for constructing training pants. Training pants can also be constructed using the methods

and apparatus disclosed in U.S. Patent 4,940,464 issued July 10, 1990 to Van Gompel et al.; and U.S. Patent 5,766,389 issued June 16, 1998 to Brandon et al.; which are also incorporated herein by reference.

5

Definitions

Within the context of this specification, each term or phrase below will include the following meaning or meanings.

"Bonded" refers to the joining, adhering, connecting, attaching, or the like, of two elements. Two elements will be considered to be bonded together when they are bonded directly to one another or indirectly to one another, such as when each is directly bonded to intermediate elements.

"Comprising" is inclusive or open-ended and does not exclude additional, unrecited elements or method steps.

"Connected" refers to the joining, adhering, bonding, attaching, or the like, of two elements. Two elements will be considered to be connected together when they are connected directly to one another or indirectly to one another, such as when each is directly connected to intermediate elements.

"Disposable" refers to articles which are designed to be discarded after a limited use rather than being laundered or otherwise restored for reuse.

"Disposed," "disposed on," and variations thereof are intended to mean that one element can be integral with another element, or that one element can be a separate structure bonded to or placed with or placed near another element.

"Elastic," "elasticized" and "elasticity" mean that property of a material or composite by virtue of which it tends to recover its original size and shape after removal of a force causing a deformation.

"Elastomeric" refers to a material or composite which can be elongated by at least 25 percent of its relaxed length and which will recover, upon release of the applied force, at least 10 percent of its elongation. It is generally preferred that the elastomeric material or composite be capable of being elongated by at least 100 percent, more preferably by at least 300 percent, of its relaxed length and recover, upon release of an applied force, at least 50 percent of its elongation.

"Fabrics" is used to refer to all of the woven, knitted and nonwoven fibrous webs.

"Flexible" refers to materials which are compliant and which will readily conform to the general shape and contours of the wearer's body.

"Force" includes a physical influence exerted by one body on another which produces acceleration of bodies that are free to move and deformation of bodies that are not free to move. Force is expressed in grams per unit area.

5 "Graphic" refers to any design, pattern, or the like that is visible on an absorbent article.

"Hydrophilic" describes fibers or the surfaces of fibers which are wetted by the aqueous liquids in contact with the fibers. The degree of wetting of the materials can, in turn, be described in terms of the contact angles and the surface tensions of the liquids and materials involved. Equipment and techniques suitable for measuring the wettability of 10 particular fiber materials or blends of fiber materials can be provided by a Cahn SFA-222 Surface Force Analyzer System, or a substantially equivalent system. When measured with this system, fibers having contact angles less than 90° are designated "wettable" or hydrophilic, while fibers having contact angles greater than 90° are designated "nonwettable" or hydrophobic.

15 "Integral" is used to refer to various portions of a single unitary element rather than separate structures bonded to or placed with or placed near one another.

"Inward" and "outward" refer to positions relative to the center of an absorbent article, and particularly transversely and/or longitudinally closer to or away from the longitudinal and transverse center of the absorbent article.

20 "Layer" when used in the singular can have the dual meaning of a single element or a plurality of elements.

"Liquid impermeable", when used in describing a layer or multi-layer laminate, means that a liquid, such as urine, will not pass through the layer or laminate, under ordinary use conditions, in a direction generally perpendicular to the plane of the layer or 25 laminate at the point of liquid contact. Liquid, or urine, may spread or be transported parallel to the plane of the liquid impermeable layer or laminate, but this is not considered to be within the meaning of "liquid impermeable" when used herein.

"Longitudinal" and "transverse" have their customary meaning. The longitudinal axis lies in the plane of the article and is generally parallel to a vertical plane that bisects a 30 standing wearer into left and right body halves when the article is worn. The transverse axis lies in the plane of the article generally perpendicular to the longitudinal axis. The article as illustrated is longer in the longitudinal direction than in the transverse direction.

"Member" when used in the singular can have the dual meaning of a single element or a plurality of elements.

35 "Nonwoven" and "nonwoven web" refer to materials and webs of material which are formed without the aid of a textile weaving or knitting process.

- "Operatively joined," with reference to the attachment of an elastic member to another element, means that the elastic member when attached to or connected to the element, or treated with heat or chemicals, by stretching, or the like, gives the element elastic properties; and with reference to the attachment of a non-elastic member to another element, means that the member and element can be attached in any suitable manner that permits or allows them to perform the intended or described function of the joinder. The joining, attaching, connecting or the like can be either directly, such as joining either member directly to an element, or can be indirectly by means of another member disposed between the first member and the first element.
- 5 "Outer cover graphic" refers to a graphic that is directly visible upon inspection of the exterior surface of a garment, and for a refastenable garment is in reference to inspection of the exterior surface of the garment when the fastening system is engaged as it would be during use.
- 10 "Permanently bonded" refers to the joining, adhering, connecting, attaching, or the like, of two elements of an absorbent garment such that the elements tend to be and remain bonded during normal use conditions of the absorbent garment.
- 15 "Refastenable" refers to the property of two elements being capable of releasable attachment, separation, and subsequent releasable reattachment without substantial permanent deformation or rupture.
- 20 "Releasably attached," "releasably engaged" and variations thereof refer to two elements being connected or connectable such that the elements tend to remain connected absent a separation force applied to one or both of the elements, and the elements being capable of separation without substantial permanent deformation or rupture. The required separation force is typically beyond that encountered while wearing the absorbent garment.
- 25 "Rupture" means the breaking or tearing apart of a material; in tensile testing, the term refers to the total separation of a material into two parts either all at once or in stages, or the development of a hole in some materials.
- 30 "Stretch bonded" refers to an elastic member being bonded to another member while the elastic member is extended at least about 25 percent of its relaxed length. Desirably, the term "stretch bonded" refers to the situation wherein the elastic member is extended at least about 100 percent, and more desirably at least about 300 percent, of its relaxed length when it is bonded to the other member.
- 35 "Stretch bonded laminate" refers to a composite material having at least two layers in which one layer is a gatherable layer and the other layer is an elastic layer. The layers

are joined together when the elastic layer is in an extended condition so that upon relaxing the layers, the gatherable layer is gathered.

"Surface" includes any layer, film, woven, nonwoven, laminate, composite, or the like, whether pervious or impervious to air, gas, and/or liquids.

5 "Tension" includes a uniaxial force tending to cause the extension of a body or the balancing force within that body resisting the extension.

"Thermoplastic" describes a material that softens when exposed to heat and which substantially returns to a nonsoftened condition when cooled to room temperature.

These terms may be defined with additional language in the remaining portions of
10 the specification.

Brief Description of the Drawings

The above-mentioned and other features of the present invention and the manner of attaining them will become more apparent, and the invention itself will be better understood by reference to the following description and the accompanying drawings, wherein similar features in different figures have been given the same reference numeral.
15

Figure 1 is a schematic view of an exemplary embodiment of an assembly section for making garments such as training pants.

Figure 2 is a schematic side view of an exemplary embodiment of a folding section
20 for making garments such as training pants, the folding section following the assembly section shown in Figure 1.

Figure 3 is a schematic side view of one embodiment of a method and apparatus for making garments according to the present invention, the view illustrating a seaming section which follows the folding section shown in Figure 2.

25 Figure 4 illustrates a side view of a training pant made by the process and apparatus shown in Figures 1-3, where the fastening system is shown engaged on one side of the training pant and disengaged on the other side of the training pant.

Figure 5 illustrates a plan view of the training pant shown in Figure 4 in an unfastened, stretched and laid flat condition, and showing the surface of the training pant
30 that faces away from the wearer.

Figure 6 illustrates a plan view similar to Figure 5, but showing the surface of the training pant that faces the wearer when the training pant is worn, and with portions cut away to show the underlying features.

Figure 7 illustrates a portion of a continuously moving assemblage at one point in
35 the assembly section illustrated in Figure 1.

Figure 8 illustrates an enlarged side view of the folding section shown in Figure 2.

Figure 9 illustrates a top view of a portion of the folding section shown in Figure 2.

Figure 10 illustrates an enlarged section view of a portion of a training pant at a position within the folding section shown in Figures 2, 8 and 9.

- 5 Figure 11 illustrates an enlarged side view of an interior panel positioning station of the seaming section shown in Figure 3.

Figures 12, 13, and 14 illustrate enlarged section views of a portion of a training pant at a series of positions within the interior panel positioning station shown in Figure 11.

- 10 Figure 15 illustrates an enlarged side view of an exterior panel positioning station of the seaming section shown in Figure 3.

Figures 16, 17, 18, and 19 illustrate enlarged section views of a portion of a training pant at a series of positions within the exterior panel positioning station shown in Figure 15.

- 15 Figure 20 illustrates an enlarged section view of the air knife shown in Figure 14.
- Figure 21 illustrates a side view of an orbital motion device partially shown in Figures 3 and 15.

Figure 22 and 23 illustrate enlarged section views of a portion of a training pant at a series of positions within an alternative interior panel positioning station.

Detailed Description of the Drawings

- 20 The methods and apparatus of the present invention can be used to fold a variety of materials and to make a variety of garments. Examples of such garments include disposable absorbent articles such as diapers, training pants, feminine hygiene products, incontinence products, other personal care or health care garments; swim pants; athletic clothing; pants and shorts; or the like. For ease of explanation, the description hereafter will be in terms of methods and apparatus for making a child's training pant. In particular, the methods and apparatus will be described in terms of those for making prefastened disposable training pants as described in U.S. Patent Application Serial Number 09/444,083 titled "Absorbent Articles With Refastenable Side Seams" and filed November 22, 1999 (corresponding to PCT application WO 00/37009 published June 29, 2000) by A. 25 L. Fletcher et al., the disclosure of which is incorporated herein by reference.
- 30

Figures 1-3 representatively illustrate one embodiment of a method and apparatus for making a training pant 20. The training pant 20 is illustrated separately and in a partially fastened condition in Figure 4. The training pant 20 comprises an absorbent chassis 32 and a fastening system 80. The absorbent chassis 32 defines a front waist region 22, a back waist region 24, a crotch region 26 interconnecting the front and back waist regions, an inner surface 28 which is configured to contact the wearer, and an outer

surface 30 opposite the inner surface which is configured to contact the wearer's clothing. With additional reference to Figures 5 and 6, the absorbent chassis 32 also defines a pair of transversely opposed side edges 36 and a pair of longitudinally opposed waist edges, which are designated front waist edge 38 and back waist edge 39. The front waist region 5 22 is contiguous with the front waist edge 38, and the back waist region 24 is contiguous with the back waist edge 39.

The illustrated absorbent chassis 32 comprises a composite structure 33 which can be rectangular or any other desired shape, a pair of transversely opposed front side panels 34, and a pair of transversely opposed back side panels 134. The composite structure 33 and side panels 34 and 134 may comprise two or more separate elements, 10 as shown in Figure 4, or be integrally formed. Integrally formed side panels and composite structure would comprise at least some common materials, such as the bodyside liner, flap composite, outer cover, other materials and/or combinations thereof, and could define a one-piece elastic, stretchable, or nonstretchable pant. The illustrated composite structure 33 comprises an outer cover 40, a bodyside liner 42 (Figures 4 and 6) which is connected to the outer cover in a superposed relation, an absorbent assembly 44 (Figure 6) which is located between the outer cover and the bodyside liner, and a pair of containment flaps 46 (Figure 6). The illustrated composite structure 33 has opposite linear end edges 45 that form portions of the front and back waist edges 38 and 39, and 15 opposite linear side edges 47 that form portions of the side edges 36 of the absorbent chassis 32 (Figures 5 and 6). For reference, arrows 48 and 49 depicting the orientation of the longitudinal axis and the transverse axis, respectively, of the training pant 20 are 20 illustrated in Figures 5 and 6.

With the training pant 20 in the fastened position as partially illustrated in Figure 4, 25 the front and back waist regions 22 and 24 are joined together to define a three-dimensional pant configuration having a waist opening 50 and a pair of leg openings 52. The front waist region 22 comprises the portion of the training pant 20 which, when worn, is positioned on the front of the wearer while the back waist region 24 comprises the portion of the training pant which, when worn, is positioned on the back of the wearer. The 30 crotch region 26 of the training pant 20 comprises the portion of the training pant which, when worn, is positioned between the legs of the wearer and covers the lower torso of the wearer. The front and back side panels 34 and 134 comprise the portions of the training pant 20 which, when worn, are positioned on the hips of the wearer.

The front waist region 22 of the absorbent chassis 32 includes the transversely 35 opposed front side panels 34 and a front center panel 35 (Figures 5 and 6) positioned between and interconnecting the side panels. The back waist region 24 of the absorbent

chassis 32 includes the transversely opposed back side panels 134 and a back center panel 135 (Figures 5 and 6) positioned between and interconnecting the side panels. The waist edges 38 and 39 of the absorbent chassis 32 are configured to encircle the waist of the wearer when worn and provide the waist opening 50 which defines a waist perimeter dimension. Portions of the transversely opposed side edges 36 in the crotch region 26 generally define the leg openings 52.

The absorbent chassis 32 is configured to contain and/or absorb any body exudates discharged from the wearer. For example, the absorbent chassis 32 desirably although not necessarily comprises the pair of containment flaps 46 which are configured to provide a barrier to the transverse flow of body exudates. A flap elastic member 53 (Figure 6) can be operatively joined with each containment flap 46 in any suitable manner as is well known in the art. The elasticized containment flaps 46 define an unattached edge which assumes an upright configuration in at least the crotch region 26 of the training pant 20 to form a seal against the wearer's body. The containment flaps 46 can be located along the transversely opposed side edges of the absorbent chassis 32, and can extend longitudinally along the entire length of the absorbent chassis or may only extend partially along the length of the absorbent chassis. Suitable constructions and arrangements for the containment flaps 46 are generally well known to those skilled in the art and are described in U.S. Patent 4,704,116 issued November 3, 1987 to Enloe, which is incorporated herein by reference.

To further enhance containment and/or absorption of body exudates, the training pant 20 desirably although not necessarily includes a front waist elastic member 54, a rear waist elastic member 56, and leg elastic members 58, as are known to those skilled in the art (Figure 6). The waist elastic members 54 and 56 can be operatively joined to the outer cover 40 and/or bodyside liner 42 along the opposite waist edges 38 and 39, and can extend over part or all of the waist edges. The leg elastic members 58 can be operatively joined to the outer cover 40 and/or bodyside liner 42 along the opposite side edges 36 and positioned in the crotch region 26 of the training pant 20. The leg elastic members 58 can be longitudinally aligned along each side edge 47 of the composite structure 33. Each leg elastic member 58 has a front terminal point 63 and a back terminal point 65, which points represent the longitudinal ends of the elastic gathering caused by the leg elastic members. The front terminal points 63 can be located adjacent the longitudinally innermost parts of the front side panels 34, and the back terminal points 65 can be located adjacent the longitudinally innermost parts of the back side panels 134.

The flap elastic members 53, the waist elastic members 54 and 56, and the leg elastic members 58 can be formed of any suitable elastic material. As is well known to

- those skilled in the art, suitable elastic materials include sheets, strands or ribbons of natural rubber, synthetic rubber, or thermoplastic elastomeric polymers. The elastic materials can be stretched and adhered to a substrate, adhered to a gathered substrate, or adhered to a substrate and then elasticized or shrunk, for example with the application
5 of heat; such that elastic constrictive forces are imparted to the substrate. In one particular embodiment, for example, the leg elastic members 58 comprise a plurality of dry-spun coalesced multifilament spandex elastomeric threads sold under the trade name LYCRA® and available from E. I. Du Pont de Nemours and Company, Wilmington, Delaware U.S.A.
- 10 The outer cover 40 desirably comprises a material that is substantially liquid impermeable, and can be elastic, stretchable or nonstretchable. The outer cover 40 can be a single layer of liquid impermeable material, but desirably comprises a multi-layered laminate structure in which at least one of the layers is liquid impermeable. For instance, the outer cover 40 can include a liquid permeable outer layer and a liquid impermeable
15 inner layer that are suitably joined together by a laminate adhesive, ultrasonic bonds, thermal bonds, or the like. Suitable laminate adhesives, which can be applied continuously or intermittently as beads, a spray, parallel swirls, or the like, can be obtained from Findley Adhesives, Inc., of Wauwatosa, Wisconsin U.S.A., or from National Starch and Chemical Company, Bridgewater, New Jersey U.S.A. The liquid permeable outer layer can be any
20 suitable material and desirably one that provides a generally cloth-like texture. One example of such a material is a 20 gsm (grams per square meter) spunbond polypropylene nonwoven web. The outer layer may also be made of those materials of which liquid permeable bodyside liner 42 is made. While it is not a necessity for outer layer to be liquid permeable, it is desired that it provides a relatively cloth-like texture to
25 the wearer.

The inner layer of the outer cover 40 can be both liquid and vapor impermeable, or can be liquid impermeable and vapor permeable. The inner layer can be manufactured from a thin plastic film, although other flexible liquid impermeable materials may also be used. The inner layer, or the liquid impermeable outer cover 40 when a single layer,
30 prevents waste material from wetting articles, such as bedsheets and clothing, as well as the wearer and caregiver. A suitable liquid impermeable film for use as a liquid impermeable inner layer, or a single layer liquid impermeable outer cover 40, is a 0.02 millimeter polyethylene film commercially available from Huntsman Packaging of Newport News, Virginia U.S.A. If the outer cover 40 is a single layer of material, it can be
35 embossed and/or matte finished to provide a more cloth-like appearance. As earlier mentioned, the liquid impermeable material can permit vapors to escape from the interior

of the disposable absorbent article, while still preventing liquids from passing through the outer cover 40. A suitable "breathable" material is composed of a microporous polymer film or a nonwoven fabric that has been coated or otherwise treated to impart a desired level of liquid impermeability. A suitable microporous film is a PMP-1 film material 5 commercially available from Mitsui Toatsu Chemicals, Inc., Tokyo, Japan, or an XKO-8044 polyolefin film commercially available from 3M Company, Minneapolis, Minnesota U.S.A.

As shown in Figures 4 and 5, the training pant 20 and in particular the outer cover 40 desirably comprises one or more appearance-related components. Examples of 10 appearance-related components include, but are not limited to, graphics; highlighting or emphasizing leg and waist openings in order to make product shaping more evident or visible to the user; highlighting or emphasizing areas of the product to simulate functional components such as elastic leg bands, elastic waistbands, simulated "fly openings" for boys, ruffles for girls; highlighting areas of the product to change the appearance of the 15 size of the product; registering wetness indicators, temperature indicators, and the like in the product; registering a back label, or a front label, in the product; and registering written instructions at a desired location in the product.

The illustrated training pant 20, which is designed for use by young girls, includes 20 a registered outer cover graphic 60. In this design, the registered graphic 60 includes a primary pictorial image 61, simulated waist ruffles 62, and simulated leg ruffles 64. The primary pictorial image 61 includes a rainbow, sun, clouds, animal characters, wagon and balloons. Any suitable design can be utilized for a training pant intended for use by young girls, so as to be aesthetically and/or functionally pleasing to them and the caregiver. The appearance-related components are desirably positioned on the training pant 20 at 25 selected locations, which can be carried out using the methods disclosed in U.S. Patent 5,766,389 issued June 16, 1998 to Brandon et al., which is incorporated herein by reference. The primary pictorial image 61 is desirably positioned in the front waist region 22 along the longitudinal center line of the training pant 20.

The liquid permeable bodyside liner 42 is illustrated as overlying the outer cover 40 30 and absorbent assembly 44, and may but need not have the same dimensions as the outer cover 40. The bodyside liner 42 is desirably compliant, soft feeling, and non-irritating to the child's skin. Further, the bodyside liner 42 can be less hydrophilic than the absorbent assembly 44, to present a relatively dry surface to the wearer and permit liquid to readily penetrate through its thickness. Alternatively, the bodyside liner 42 can be more 35 hydrophilic or can have essentially the same affinity for moisture as the absorbent assembly 44 to present a relatively wet surface to the wearer to increase the sensation of

being wet. This wet sensation can be useful as a training aid. The hydrophilic/hydrophobic properties can be varied across the length, width and depth of the bodyside liner 42 and absorbent assembly 44 to achieve the desired wetness sensation or leakage performance.

- 5 The bodyside liner 42 can be manufactured from a wide selection of web materials, such as synthetic fibers (for example, polyester or polypropylene fibers), natural fibers (for example, wood or cotton fibers), a combination of natural and synthetic fibers, porous foams, reticulated foams, apertured plastic films, or the like. Various woven and nonwoven fabrics can be used for the bodyside liner 42. For example, the bodyside liner
10 can be composed of a meltblown or spunbonded web of polyolefin fibers. The bodyside liner can also be a bonded-carded web composed of natural and/or synthetic fibers. The bodyside liner can be composed of a substantially hydrophobic material, and the hydrophobic material can, optionally, be treated with a surfactant or otherwise processed to impart a desired level of wettability and hydrophilicity. For example, the material can be
15 surface treated with about 0.45 weight percent of a surfactant mixture comprising Ahcovel N-62 from Hodgson Textile Chemicals of Mount Holly, North Carolina U.S.A. and Glucopan 220UP from Henkel Corporation of Ambler, Pennsylvania in an active ratio of 3:1. The surfactant can be applied by any conventional means, such as spraying, printing, brush coating or the like. The surfactant can be applied to the entire bodyside liner 42 or
20 can be selectively applied to particular sections of the bodyside liner, such as the medial section along the longitudinal center line.

A suitable liquid permeable bodyside liner 42 is a nonwoven bicomponent web having a basis weight of about 27 gsm. The nonwoven bicomponent can be a spunbond bicomponent web, or a bonded carded bicomponent web. Suitable bicomponent staple fibers include a polyethylene/polypropylene bicomponent fiber available from CHISSO Corporation, Osaka, Japan. In this particular bicomponent fiber, the polypropylene forms the core and the polyethylene forms the sheath of the fiber. Other fiber orientations are possible, such as multi-lobe, side-by-side, end-to-end, or the like. The outer cover 40, bodyside liner 42 and other materials used to construct the pant can comprise elastomeric
25 or nonelastomeric materials.

- 30 The absorbent assembly 44 (Figure 6) is positioned between the outer cover 40 and the bodyside liner 42, which components can be joined together by any suitable means such as adhesives, ultrasonic bonds, thermal bonds, or the like. The absorbent assembly 44 can be any structure which is generally compressible, conformable, non-irritating to the
35 child's skin, and capable of absorbing and retaining liquids and certain body wastes. The absorbent assembly 44 can be manufactured in a wide variety of sizes and shapes, and

from a wide variety of liquid absorbent materials commonly used in the art. For example, the absorbent assembly 44 can suitably comprise a matrix of hydrophilic fibers, such as a web of cellulosic fluff, mixed with particles of a high-absorbency material commonly known as superabsorbent material. In a particular embodiment, the absorbent assembly 44 5 comprises a matrix of cellulosic fluff, such as wood pulp fluff, and superabsorbent hydrogel-forming particles. The wood pulp fluff can be exchanged with synthetic, polymeric, meltblown fibers or short cut homofil bicomponent synthetic fibers and natural fibers. The superabsorbent particles can be substantially homogeneously mixed with the hydrophilic fibers or can be nonuniformly mixed. The fluff and superabsorbent particles 10 can also be selectively placed into desired zones of the absorbent assembly 44 to better contain and absorb body exudates. The concentration of the superabsorbent particles can also vary through the thickness of the absorbent assembly 44. Alternatively, the absorbent assembly 44 can comprise a laminate of fibrous webs and superabsorbent material or other suitable means of maintaining a superabsorbent material in a localized area.

15 Suitable superabsorbent materials can be selected from natural, synthetic, and modified natural polymers and materials. The superabsorbent materials can be inorganic materials, such as silica gels, or organic compounds, such as crosslinked polymers, for example, sodium neutralized polyacrylic acid. Suitable superabsorbent materials are available from various commercial vendors, such as Dow Chemical Company located in 20 Midland, Michigan U.S.A., and Stockhausen GmbH & Co. KG, D-47805 Krefeld, Federal Republic of Germany. Typically, a superabsorbent material is capable of absorbing at least about 15 times its weight in water, and desirably is capable of absorbing more than about 25 times its weight in water.

In one embodiment, the absorbent assembly 44 which can be rectangular or any 25 other desired shape comprises a blend of wood pulp fluff and superabsorbent material. One preferred type of pulp is identified with the trade designation CR1654, available from U.S. Alliance, Childersburg, Alabama U.S.A., and is a bleached, highly absorbent sulfate wood pulp containing primarily soft wood fibers and about 16 percent hardwood fibers. As a general rule, the superabsorbent material is present in the absorbent assembly 44 in an 30 amount of from 0 to about 90 weight percent based on total weight of the absorbent assembly. The absorbent assembly 44 suitably has a density within the range of about 0.10 to about 0.35 grams per cubic centimeter. The absorbent assembly 44 may or may not be wrapped or encompassed by a suitable tissue wrap that may help maintain the integrity and/or shape of the absorbent assembly.

35 The absorbent chassis 32 can also incorporate other materials that are designed primarily to receive, temporarily store, and/or transport liquid along the mutually facing

surface with absorbent assembly 44, thereby maximizing the absorbent capacity of the absorbent assembly. One suitable material is referred to as a surge layer (not shown) and comprises a material having a basis weight of about 50 to about 120 grams per square meter, and comprising a through-air-bonded-carded web of a homogenous blend of 5 60 percent 3 denier type T-256 bicomponent fiber comprising a polyester core/polyethylene sheath and 40 percent 6 denier type T-295 polyester fiber, both commercially available from Kosa Corporation of Salisbury, North Carolina U.S.A.

As noted previously, the illustrated training pant 20 has front and back side panels 34 and 134 disposed on each side of the absorbent chassis 32. These transversely 10 opposed front side panels 34 and transversely opposed back side panels 134 can be permanently bonded along attachment lines 66 to the composite structure 33 of the absorbent chassis 32 in the respective front and back waist regions 22 and 24. More particularly, as shown best in Figures 5 and 6, the front side panels 34 can be permanently bonded to and extend transversely beyond the linear side edges 47 of the 15 composite structure 33 in the front waist region 22, and the back side panels 134 can be permanently bonded to and extend transversely beyond the linear side edges of the composite structure in the back waist region 24. The side panels 34 and 134 may be attached using attachment means known to those skilled in the art such as adhesive, thermal or ultrasonic bonding. Alternatively, the side panels 34 and 134 can be formed as 20 an integral portion of a component of the composite structure 33. For example, the side panels can comprise a generally wider portion of the outer cover 40, the bodyside liner 42, and/or another component of the absorbent chassis. The front and back side panels 34 and 134 can be permanently bonded together or be releasably attached to one another as illustrated by the fastening system 80.

25 The illustrated side panels 34 and 134 each define a distal edge 68 that is spaced from the attachment line 66, a leg end edge 70 disposed toward the longitudinal center of the training pant 20, and a waist end edge 72 disposed toward a longitudinal end of the training pant. The leg end edge 70 and waist end edge 72 extend from the side edges 47 of the composite structure 33 to the distal edges 68. The leg end edges 70 of the side 30 panels 34 and 134 form part of the side edges 36 of the absorbent chassis 32. In the back waist region 24, the leg end edges 70 are desirably although not necessarily curved and/or angled relative to the transverse axis 49 to provide greater coverage toward the back of the pant as compared to the front of the pant. The waist end edges 72 are desirably parallel to the transverse axis 49. The waist end edges 72 of the front side 35 panels 34 form part of the front waist edge 38 of the absorbent chassis 32, and the waist

end edges 72 of the back side panels 134 form part of the back waist edge 39 of the absorbent chassis.

In particular embodiments for improved fit and appearance, the side panels 34 and 134 desirably have an average length dimension measured parallel to the longitudinal axis 48 that is about 20 percent or greater, and particularly about 25 percent or greater, of the overall length dimension of the absorbent article, also measured parallel to the longitudinal axis 48. For example, in training pants having an overall length dimension of about 54 centimeters, the side panels 34 and 134 desirably have an average length dimension of about 10 centimeters or greater, such as about 15 centimeters. While each 5 of the side panels 34 and 134 extend from the waist opening 50 to one of the leg openings 52, the illustrated back side panels 134 have a continually decreasing length dimension moving from the attachment line 66 to the distal edge 68, as is best shown in Figures 5 and 6.

Each of the side panels 34 and 134 can include one or more individual, distinct 15 pieces of material. In particular embodiments, for example, each side panel 34 and 134 can include first and second side panel portions that are joined at a seam, or can include a single piece of material which is folded over upon itself (not shown).

The side panels 34 and 134 desirably although not necessarily comprise an elastic material capable of stretching in a direction generally parallel to the transverse axis 49 of 20 the training pant 20. Suitable elastic materials, as well as one process of incorporating elastic side panels into a training pant, are described in the following U.S. Patents: 4,940,464 issued July 10, 1990 to Van Gompel et al.; 5,224,405 issued July 6, 1993 to Pohjola; 5,104,116 issued April 14, 1992 to Pohjola; and 5,046,272 issued September 10, 1991 to Vogt et al.; all of which are incorporated herein by reference. In 25 particular embodiments, the elastic material comprises a stretch-thermal laminate (STL), a neck-bonded laminate (NBL), a reversibly necked laminate, or a stretch-bonded laminate (SBL) material. Methods of making such materials are well known to those skilled in the art and described in U.S. Patent 4,663,220 issued May 5, 1987 to Wisneski et al.; U.S. Patent 5,226,992 issued July 13, 1993 to Morman; and European Patent Application 30 No. EP 0 217 032 published on April 8, 1987 in the names of Taylor et al.; all of which are incorporated herein by reference. Alternatively, the side panel material may comprise other woven or nonwoven materials, such as those described above as being suitable for the outer cover 40 or bodyside liner 42; mechanically pre-strained composites; or stretchable but inelastic materials.

35 The illustrated training pant 20 includes a fastening system 80 for refastenably securing the training pant about the waist of the wearer. The illustrated fastening system

80 includes first fastening components 82 and 83 that are adapted to refastenably connect to mating second fastening components 84 and 85. In one embodiment, one surface of each of the first fastening components 82 and 83 comprises a plurality of engaging elements that project from that surface. The engaging elements of the first 5 fastening components 82 and 83 are adapted to repeatedly engage and disengage engaging elements of the second fastening components 84 and 85.

In one particular embodiment, the first fastening components 82 and 83 each comprise hook type fasteners and the second fastening components 84 and 85 each comprise complementary loop type fasteners. In another particular embodiment, the first 10 fastening components 82 and 83 each comprise loop type fasteners and the second fastening components 84 and 85 each comprise complementary hook type fasteners. Alternatively, the fastening components can comprise interlocking similar surface fasteners; adhesive or cohesive fastening elements such as an adhesive fastener and an adhesive-receptive landing zone or material; or the like. Although the illustrated 15 embodiments show the back waist region 24 overlapping the front waist region 22, which is convenient, the training pant 20 can also be configured so that the front waist region overlaps the back waist region.

Loop type fasteners typically comprise a fabric or material having a base or backing structure and a plurality of loop members extending upwardly from at least one 20 surface of the backing structure. The loop material can be formed of any suitable material, such as acrylic, nylon, polypropylene or polyester, and can be formed by methods such as warp knitting, stitch bonding or needle punching. Loop type materials can also comprise any fibrous structure capable of entangling or catching hook type materials, such as carded, spunbonded or other nonwoven webs or composites, including elastomeric and 25 nonelastomeric composites. Suitable loop materials are available from Guilford Mills, Inc., Greensboro, North Carolina, U.S.A. under the trade designation No. 36549. Another suitable loop material can comprise a pattern un-bonded web as disclosed in U.S. Patent 5,858,515 issued January 12, 1999 to Stokes et al.

Hook type fasteners typically comprise a fabric or material having a base or 30 backing structure and a plurality of hook members extending upwardly from at least one surface of the backing structure. In contrast to the loop type fasteners which desirably comprise a flexible fabric, the hook material advantageously comprises a resilient material to minimize unintentional disengagement of the fastener components as a result of the hook material becoming deformed and catching on clothing or other items. The term 35 "resilient" as used herein refers to an interlocking material having a predetermined shape and the property of the interlocking material to resume the predetermined shape after

- being engaged and disengaged from a mating, complementary interlocking material. Suitable hook material can be molded or extruded of nylon, polypropylene or another suitable material. Suitable single-sided hook materials for the fastening components 82-85 are available from commercial vendors such as Velcro Industries B.V., Amsterdam, Netherlands or affiliates thereof, and are identified as Velcro HTH-829 with a uni-directional hook pattern and having a thickness of about 0.9 millimeters (35 mils) and HTH-851 with a uni-directional hook pattern and having a thickness of about 0.5 millimeters (20 mils); and Minnesota Mining & Manufacturing Co., St. Paul, Minnesota U.S.A., including specific materials identified as CS-600.
- With particular reference to Figure 6, the first fastening components 82 and 83 are desirably although not necessarily disposed on the inner surface 28 of the training pant 20 in the back waist region 24. The first fastening components 82 and 83 are desirably positioned along the distal edges 68 of the back side panels 134, and abutting or adjacent to the waist end edge 72. In certain embodiments, for example, the first fastening components 82 and 83 can be located within about 2 centimeters, and more particularly within about 1 centimeter, of the distal edges 68, the waist end edges 72, and the leg end edges 70.
- With particular reference to Figure 5, the second fastening components 84 and 85 are desirably although not necessarily disposed on the outer surface 30 of the training pant 20 in the front waist region 22. The second fastening components 84 and 85 are sized to receive the first fastening components 82 and 83 and are desirably positioned along the distal edges 68 of the front side panels 34, and abutting or adjacent to the waist end edge 72. In certain embodiments, for example, the second fastening components 84 and 85 can be located within about 2 centimeters, and more particularly within about 1 centimeter, of the distal edges 68, the waist end edges 72, and the leg end edges 70. Where the first fastening components 82 and 83 comprise loop type fasteners disposed on the inner surface 28 and the second fastening components 84 and 85 comprise hook type fasteners disposed on the outer surface 30, the first fastening components can be sized larger than the second fastening components to ensure coverage of the rigid, outwardly-directed hooks.
- The fastening components 82-85 can be adhered to the side panels 34 and 134 by any means known to those skilled in the art such as adhesive bonds, ultrasonic bonds or thermal bonds. The fastening components can comprise separate fastening elements or can comprise distinct regions of an integral material. For example, the training pant 20 can include an integral second fastening material disposed in the front waist region 22 for refastenably connecting to the first fastening components 82 and 83 at two or more

different regions, which define the second fastening components 84 and 85 (Figure 3). In a particular embodiment, the fastening components can comprise integral portions of the waist regions. For instance, one of the elastomeric front or back side panels can function as second fastening components in that they can comprise a material that is releasably engageable with fastening components disposed in the opposite waist region.

The fastening components are desirably rectangular, although they may alternatively be square, round, oval, curved or otherwise non-rectangularly shaped. In particular embodiments, each of the fastening components 82-85 defines a length dimension aligned generally parallel with the longitudinal axis 48 of the training pant 20 and a width dimension aligned generally parallel with the transverse axis 49 of the training pant. For a child of about 9 to about 15 kilograms (20-30 pounds), for example, the length dimension of the fastening components is desirably from about 5 to about 13 centimeters, such as about 10 centimeters, and the width dimension is desirably from about 0.5 to about 3 centimeters, such as about 1 centimeter. With particular embodiments, the fastening components can have a length-to-width ratio of about 2 or greater, such as about 2 to about 25, and particularly about 5 or greater, such as about 5 to about 8. For other embodiments such as for adult products, it may be desirable for one or more of the fastening components to comprise a plurality of relatively smaller fastening elements. In that case, a fastening component or individual fastening elements may have an even smaller length-to-width ratio, for example, of about 2 or less, and even about 1 or less.

When the fastening components 82-85 are releasably engaged, the side edges 36 of the absorbent chassis 32 in the crotch region 26 define the leg openings 52, and the waist edges 38 and 39 of the absorbent chassis, including the waist end edges 72 of the side panels, define the waist opening 50. For improved formation of the leg openings 52, it can be desirable in some embodiments for the front side panels 34 to be longitudinally spaced from the back side panels 134 (see Figures 5 and 6). For example, the front side panels 34 can be longitudinally spaced from the back side panels 134 by a distance equal to about 20 percent or greater, particularly from about 20 to about 60 percent, and more particularly from about 35 to about 50 percent, of the overall length dimension of the absorbent article.

When connected, the fastening components 82-85 form refastenable seams 88 (Figure 4) that desirably although not necessarily extend substantially the entire distance between the waist opening 50 and the leg openings 52. More specifically, the refastenable seams 88 can cover about 80 to 100 percent, and particularly about 90 to about 98 percent, of the distance between the waist opening 50 and each leg opening 52, which distance is measured parallel to the longitudinal axis 48. To construct the seams 88 to

extend substantially the entire distance between the waist and leg openings 50 and 52, the fastening components 82-85 can be formed to cover about 80 to 100 percent, and more particularly about 90 to about 98 percent, of the distance between the waist end edge 70 and the leg end edge 72 of the side panels 34 and 134. In other embodiments, 5 the fastening components can comprise a plurality of smaller fastening elements covering a smaller portion of the distance between the waist opening 50 and the leg openings 52, for example, about 20 to about 70 percent, but spaced apart to span a larger percentage of the distance between the waist opening and the leg openings.

For the refastenable seams 88 to be located at the sides of the wearer, it can be 10 particularly desirable for the transverse distance between the first fastening components 82 and 83 to be substantially equal to the transverse distance between the second fastening components 84 and 85. The transverse distance between a set of fasteners is measured parallel to the transverse axis 49 between the longitudinal center lines of the fasteners, measured with the side panels 34 and 134 in an unstretched condition.

15 An exemplary embodiment of an assembly section 100 for making a continuous stream of partially assembled, discrete training pants 102 is illustrated in Figure 1. The specific equipment and processes used in the assembly section 100 can vary greatly depending on the specific type of garment being manufactured. The particular process and apparatus described in relation to Figure 1 is specifically adapted to manufacture 20 training pants 20 of the type illustrated in Figure 4.

The various components of the training pant can be connected together by any means known to those skilled in the art such as, for example, adhesive, thermal and/or ultrasonic bonds. Desirably, most of the components are connected using ultrasonic bonding for improved manufacturing efficiency and reduced raw material costs. Certain 25 garment manufacturing equipment which is readily known and understood in the art, including frames and mounting structures, ultrasonic and adhesive bonding devices, transport conveyors, transfer rolls, guide rolls, tension rolls, and the like, have not been shown in Figures 1 and 2. Suitable absorbent supply mechanisms, web unwinds, conveyor systems, registration systems, drives systems, control systems and the like, for 30 use with the present process are disclosed in U.S. Patent 5,766,389 issued June 16, 1998 to Brandon et al., which is incorporated herein by reference. Also, the outer cover graphics 61 are not shown in Figures 1, 2 and 7.

A continuous supply of material 104 used to form the bodyside liner 42 is provided from a supply source 106. The supply source 106 can comprise for example any standard 35 unwind mechanism, which generally includes a pair of spindles, a festoon assembly, and a dancer roll for providing bodyside liner material 104 at a desired speed and tension.

Various components can be disposed on and/or bonded to the bodyside liner material 104 as the material travels in a machine direction identified by arrow 108. In particular, a surge layer can be provided at an application station 110 and disposed on and/or bonded to the bodyside liner material 104. The surge layer can comprise either a continuous web or discrete sheets. Additionally, a containment flap module 112 can be provided downstream of the supply source 106 for attaching pre-assembled containment flaps to the bodyside liner material 104. As various components are added in the assembly section 100, a continuously moving product assemblage 113 is formed. The product assemblage 113 will be cut downstream to form the partially assembled, discrete training pants 102.

A plurality of absorbent assemblies 114 can be provided from a suitable supply source 115. The supply source 115 can be any conventional mechanism for supplying the absorbent assemblies 114. Generally, a conventional supply source can include a hammermill for forming fluff fibers and, if desired, for providing an enclosure for mixing superabsorbent material with the fluff fibers, and then depositing the fluff and superabsorbent material on a forming drum having a desired absorbent design. The individual absorbent assemblies 114 can be disposed intermittently on the continuously moving bodyside liner material 104, one for each training pant. The position of the absorbent assemblies 114 can be registered with the position of the surge material, if employed. The absorbent assemblies 114 can be bonded to one or more other components using adhesives or other suitable means. Alternatively, composite absorbent materials can be fed into the converting process from rolls or compressed packages, such as festooned bales.

Continuous webs of material 116 used to form the side panels 34 and 134 can be provided from suitable supply sources 117. The supply sources 117 can comprise one or more standard unwind mechanisms. The side panel material 116 can be cut into individual strips 118 and positioned partially on the bodyside liner material 104 using an applicator device 120. In the cross machine direction, the individual strips 118 desirably extend laterally outward from the bodyside liner material 104 (see Figures 1 and 7) and overlap laterally outward from the bodyside liner material by an amount such as about 2 or more centimeters to permit bonding of the strips to the bodyside liner and/or the containment flap material. In the machine direction 108, the position of the strips 118 can be registered relative to the absorbent assemblies 114 so that the product assemblage 113 can be cut between the absorbent assemblies with each strip 118 of side panel material 116 forming both a front side panel 34 and a back side panel 134 of consecutive garments 102.

One suitable applicator device 120 is disclosed in U.S. Patents 5,104,116 issued April 14, 1992 and 5,224,405 issued July 6, 1993 both to Pohjola, which are incorporated herein by reference. The applicator device 120 can comprise a cutting assembly 122 and a rotatable transfer roll 124. The cutting assembly 122 employs a rotatable knife roll 126 and a rotatable vacuum anvil roll 128 to cut individual strips 118 from the continuous side panel material 116. The strips 118 cut by a blade on the knife roll 126 can be maintained on the anvil roll 128 by vacuum and transferred to the transfer roll 124.

The rotatable transfer roll 124 can comprise a plurality of rotatable vacuum pucks 130. The vacuum pucks 130 receive the strips 118 of material 116 from the cutting assembly 122 and rotate and transfer the strips to the continuously moving bodyside liner material 104. When the strips 118 are positioned as desired relative to the bodyside liner material 104, the strips are released from the pucks 130 by extinguishing the vacuum in the pucks. The pucks 130 can continue to rotate toward the cutting assembly 122 to receive other strips.

As disclosed by Van Gompel et al., the material 116 used to form the side panels can alternatively be provided in continuous form and pressurized fluid-jets or a rotary die cutter can be employed to cut the material to form leg openings 52. Still alternatively, the side panels 34 and 134 of the training pant 20 can be provided by portions of the bodyside liner 42 and/or outer cover 40.

A continuous supply of material 140 used to form the outer cover 40 can be provided from a supply roll 142 or other suitable source. The outer cover material 140 can be transported over a laminator roll 144 and married with the bodyside liner material 104. The absorbent assemblies 114 are thereby sandwiched between the continuous materials 104 and 140. The inward portions of the strips 118 of side panel material 116 can also be disposed between the bodyside liner material 104 and the outer cover material 140. Alternative configurations for attaching the side panel material 116 are disclosed by Van Gompel et al. Various components such as leg elastics 58 or waist elastics 54 and 56 can be bonded to the outer cover material 140 at an application station 146 prior to uniting the bodyside liner and outer cover materials 104 and 140. Alternatively, leg elastics or waist elastics can be initially bonded to the bodyside liner material 104 or another material.

Bonding devices 148 such as ultrasonic bonders can be employed downstream of the laminator roll 144 to bond the bodyside liner material 104, side panel material 116 and outer cover material 140. For example, these materials can be transported between a rotary ultrasonic horn and an anvil roll. Suitable rotary ultrasonic horns are described in U.S. Patent 5,110,403 to Ehlert, which is incorporated herein by reference. Such rotary

ultrasonic horns generally have a diameter of from about 5 to about 20 centimeters and a width of from about 2 to about 15 centimeters. Alternatively, the ultrasonic horn may be a stationary ultrasonic horn as are also known to those skilled in the art. Other suitable ultrasonic horns and ultrasonic bonders are commercially available from Branson Sonic Power Company, Danbury, Connecticut U.S.A. The bonding devices 148 could otherwise be a thermal or adhesive bonder as are well known.

The continuously moving product assemblage 113 next advances to a fastener application station 150 where fastening components 82-85 are bonded to the strips 118 of side panel material 116. The location of the fastening components on the composite is a function in part of the configuration of the assembly section 100. The illustrated assembly section 100 is configured so that the upwardly facing surface of the product assemblage 113 will become the outer surface 30 of the training pant 20 and the downwardly facing surface will become the inner surface 28. Moreover, the illustrated assembly section 100 is configured to produce partially assembled training pants 102 having the front waist region 22 of a leading garment connected to the back waist region 24 of a trailing garment. The process could alternatively employ any combination of different orientations. For example, the upwardly facing surface of the product assemblage could form the inner surface 28 of finished garments. Additionally or alternatively, the back waist region 24 of a leading garment can be connected to the front waist region 22 of the trailing garment, or the garments can be arranged in a front-to-front/back-to-back relationship. Still alternatively, the assembly section 100 could be constructed as a cross-machine direction process wherein the longitudinal axis 48 of each garment could be perpendicular to the machine direction 108 during part or all of the assembly process.

The location of the fastening components 82-85 in this embodiment is best illustrated in Figure 7, which shows a portion of the product assemblage 113 which is moving in the direction of arrow 108 immediately following the fastener application station 150. Each individual strip 118 of side panel material 116 defines a leading edge 152, a trailing edge 154, a distal edge 156 and an interior edge 158. A dashed line 159 illustrates the location at which the product assemblage 113 can subsequently be cut to provide the discrete training pants 102. Based on the illustrated orientation of the continuously moving product assemblage 113, the first fastening components 82 and 83 can be bonded to the underside of the strips 118 and the second fastening components 84 and 85 can be bonded to the top of the strips. Additionally, the first fastening components 82 and 83 can be disposed relatively closer to the trailing edge 154 and the second fastening components 84 and 85 can be disposed relatively closer to the leading edge 152. The first

fastening components 82 and 83 can be spaced in the machine direction 108 from the second fastening components 84 and 85 so that the cut line 159 passes therebetween.

With reference again to Figure 1, continuous webs of second fastener material 160 used to form the second fastening components 84 and 85 can be provided from supply rolls 162 or other suitable sources. The second fastener materials 160 can be cut into individual second fasteners 84 and 85 by cutting assemblies 164 or other suitable devices. The illustrated cutting assemblies 164 include rotatable knife rolls 166, rotatable vacuum anvil rolls 167, and rotatable backing rolls 168. The continuous second fastener materials 160 can be cut by blades on the knife rolls 166, maintained on the anvil rolls 167 by vacuum, and disposed on the top surfaces of the strips 118 of side panel material 116.

Similarly, continuous webs of first fastener material 170 used to form the first fastening components 82 and 83 can be provided from supply rolls 172 or other suitable sources. The first fastener materials 170 can be cut into individual first fasteners 82 and 83 by cutting assemblies 174 or other suitable devices. The illustrated cutting assemblies 174 include rotatable knife rolls 176, rotatable vacuum anvil rolls 177, and rotatable backing rolls 178. The continuous first fastener materials 170 can be cut by blades on the knife rolls 176, maintained on the anvil rolls 177 by vacuum, and disposed on the undersides of the strips 118 of side panel material 116.

Other arrangements can be used to attach the fastening components 82-85. For example, the fastening components can be applied to the side panel material 116 prior to uniting the side panel material with the bodyside liner material 104 and/or the outer cover material 140; the fastening components can be applied to the bodyside liner material 104 and/or outer cover material 140, whether separate side panels are used or not; portions of other components such as the bodyside liner and/or outer cover can form one or more of the fastening components; the separate side panels or integral side panels can themselves form one or more of the fastening components; the fastening components can be attached as pre-engaged composites 82, 84 and 83, 85; or the like.

After the fastening components are disposed on the strips 118 of side panel material 116, bonding devices 180 such as ultrasonic bonders can be employed to bond the fastening components to the strips. For example, the strips 118 can be transported between a rotary ultrasonic horn and an anvil roll, which devices are positioned on each side of the process at the cross machine direction location of the fastening components 82, 84 and 83, 85. Particular ultrasonic bond patterns comprising individual, circular bonds which are compatible with mechanical fastening materials are disclosed in U.S. Patent 5,660,666 issued August 26, 1997 to Dilnik et al., which is incorporated herein by reference. Efficient arrangements for attaching the fastening components with

nonadhesive bonding devices are further described in U.S. Patent Application Serial No. unknown, filed on May 15, 2001 by J. D. Coenen et al. and titled "Methods For Making Garments With Fastening Components," which is incorporated herein by reference. For secure attachment, it may be desirable to attach the fastening components with both adhesive and thermal bonds. Suitable attachment adhesives are available from commercial vendors such as Findley Adhesive, Inc., Wauwatosa, Wisconsin U.S.A.

In particular embodiments, the bonding devices 180 can provide timed, non-uniform bonding of the fastening components to the side panel material 116. The degree of bonding, such as the number of bonds per unit area or the bond strength per unit area, can be greater in certain target areas compared to non-target areas. Enhanced bonding in target areas can be beneficial particularly near the waist and leg openings 50 and 52 to reduce delamination of the fastening components from the side panel material 116. Thus, the bonding devices 180 can be adapted to create relatively more bonds or stronger bonds between the fastening components 82-85 and the side panel material 116 when the side panel material 116 reaches a particular machine direction 108 location. In one particular embodiment, the target areas correspond to portions of the fastening components 82-85 near the waist edges 38 and 39. The bonding devices 180 can be registered to provide a relatively higher degree of bonding which begins while disposed on one fastening component (such as 84 in Figure 7), continues through the region where the product assemblage 113 will subsequently be cut (see cut line 159 in Figure 7), and ends after being disposed on another fastening component (such as 82). Alternatively, the bonding devices 180 can destroy engaging elements of the fastening components 82-85 in the target areas, so that the fastening components will be less able to aggressively attach to one another in the target areas.

The strips 118 of side panel material 116 can be trimmed if desired, for example to provide angled and/or curved leg end edges 70 in the back waist region 24 (Figures 5 and 6). To this end, the assembly section 100 can include a die cutting roll 182 and a backing roll 184. In the illustrated embodiment, a portion of each strip 118 is trimmed from the trailing edge 154 (Figure 7) in order to form the angled and/or curved leg end edges 70 in the back waist region 24.

The method and apparatus to this point provides a continuous web of interconnected and partially assembled training pants moving in the direction indicated by arrow 108. This continuously moving product assemblage 113 is passed through a cutter 186 which selectively cuts the web into discrete, partially assembled training pants 102. Such cutters 186 are generally known to those skilled in the art and can include, for example, the combination of a cutting roll 187 and an anvil roll 188 through which the web

travels (Figure 2). The anvil roll 188 can include a hardened steel rotating roll while the cutting roll 187 can include one or more flexible hardened steel blades clamped onto another rotating roll. The pinching force between the blade on the cutting roll 187 and the anvil roll 188 creates the cut. The cutting roll 187 can have one or more blades depending upon the desired distance between the cuts. The cutter 186 can further be configured to provide a spacing between the individual cut pieces after they are cut. Such a spacing can be provided by transferring the cut pieces away from the cutter at a higher speed than the speed at which the web is provided to the cutter.

The discrete training pants 102 can then be folded at a folding station 200 using any suitable folding mechanism 202 (Figure 2). The training pants 102 can be folded about a fold line generally bisecting the training pants. As such, the waist regions 22 and 24 of each training pant 102 are positioned in facing relationship with the side panels 34 and 134 extending laterally outward relative to the longitudinal axis 48 of the training pant. The fold line can extend in a lateral direction through the crotch region 26 of the training pant. Desirably, each discrete training pant 102 is consistently folded about the fold line such that the front and back waist edges 38 and 39 of the training pant align with each other.

A variety of folding mechanisms 202 can be used, such as blade folders, linear folders, book folders, tucker blades or the like. The specific type selected for a given application may depend upon the type of garment being manufactured and the type of fastening mechanism used to secure the garment in a pant configuration. An embodiment of a blade folding mechanism 202 adapted for use with garments incorporating refastenable fastening components 82-85 is illustrated in Figures 2, 8 and 9. The illustrated folding mechanism 202 controls the side panels 34 and 134 during folding so that the refastenable fastening components 82-85 are unlikely to engage one another or engage another material during the folding operation. Other arrangements for maintaining separation of the side panels and fastening components during folding are disclosed in U.S. Patent Application Serial No. unknown, filed on May 15, 2001 by J. D. Coenen et al. and titled "Folding And Manufacture Of Pants," which is incorporated herein by reference.

The illustrated blade folding mechanism 202 comprises a plurality of rotating folding or tucker blades which are configured to contact the training pant 102 along the fold line. Rotation of the folding blades can force the training pant 102 into a nip 204 between two rotating folding conveyors 206 and 208 causing the training pants to fold about the fold line. The folding conveyors 206 and 208 can form part of a transport system for moving the folded training pants 102 in the machine direction 108. The folded training pants 102 are illustrated as being transported in the machine direction 108 with

the crotch region 26 leading the waist regions 22 and 24. Alternatively, the process and apparatus could be modified so that the waist regions lead the crotch region (not shown).

- With reference to Figures 2, 8 and 9, the series of unfolded, discrete training pants 102 can be transferred from the vacuum anvil roll 188 of the cutter 186 to the upper folding conveyor 206. The training pants 102 can be held by vacuum on the upper folding conveyor 206 and transported toward the nip 204 formed between the folding conveyors 206 and 208. While being transported toward the nip 204, the side panels 34 and 134 can be smoothed out or straightened if desired by various means including fluid stabilizing devices. For example, air knives 215 (Figure 8), air bars, air nozzles or the like can be mounted in proximity to the upper folding conveyor to provide a stream of fluid directed toward the side panels to stabilize and/or straighten the side panels. The air knives 215 can blow the side panels 34 and 134 against skid plates 216 positioned transversely outward from the upper folding conveyor belt 212. Alternatively, or in addition thereto, the upper folding conveyor 206 can incorporate fluid stabilizing devices consisting of fluid manifolds operatively connected to a high pressure fluid source to fluidly shake the side panels. The fluid stabilizing devices desirably prevent folding of the side panels 34 and 134 as the training pant 102 moves along the upper folding conveyor 206. Sensing devices can also be employed at this point to detect products that have folded side panels or that are misaligned relative to the machine center line.
- The product folding nip 204 can be formed between a timed vacuum nose roll 218 of the upper folding conveyor 206 and a timed vacuum nose roll 219 of the lower folding conveyor 208 (Figures 2 and 8). As the leading edge of a pant 102 is introduced onto the upper nose roll 218, compressed air can be introduced inside the nose roll to negate vacuum draw of the nose roll. This allows the leading edge of the pant to pass by the nose roll 218 without getting sucked into the nip 204. Alternatively of course, the vacuum source can be temporarily disconnected from the nose roll 218. Any suitable control system can be used to repeatedly activate and deactivate vacuum operation of the nose rolls 218 and 219. In particular embodiments, rotary valves can be employed to cycle vacuum to the nose rolls 218 and 219.
- A product control drum 220 can guide the leading half of the training pant 102 onto a curved transfer plate 222 (Figures 2 and 8). The product control drum 220 can comprise a plurality of vacuum pucks 224 which rotate in the direction of arrow 225. The illustrated product control drum 220 includes four vacuum pucks 224 to guide four training pants 102 per revolution. Rotation of the product control drum 220 can be timed so that a vacuum puck 224 grabs the leading half of a training pant 102 and transfers the leading edge onto the curved transfer plate 222. The absorbent chassis 32 and/or side panels 134 of the

leading half can be carried on a vacuum puck 224 past the nose roll 219 of the lower folding conveyor 208. Compressed air can be introduced inside this lower nose roll 219 at this point to negate vacuum draw and permit the entire leading edge and side panels 134 to transfer onto the curved transfer plate 222. Alternatively of course, the vacuum source 5 can be temporarily disconnected from the nose roll 219.

With reference to Figure 9, the folding mechanism 202 can comprise a pair of opposed tucker blades 240 that move in an orbital manner to pass through the vertical path of the training part 102. The tucker blades 240 can contact the crotch region 26 of the part 102 and insert the crotch region into the folding nip 204. As this happens, the 10 leading half of the part 102 reverses direction over the curved transfer plate 222 and is pulled into the nip 204. The vacuum puck 224 can cease drawing vacuum at this point to release the leading half. Correspondingly, the trailing half of the part 102 is pulled around the upper nose roll 218. Thus, both halves of the training part 102 can change from motion in a generally vertical plane to motion between the folding conveyors 206 and 208 15 in a generally horizontal plane.

The illustrated folding mechanism 202 can maintain separation between the front and back side panels 34 and 134. As the part 102 enters the folding nip 204, compressed air can be shut off to the upper nose roll 218 so that the side panels 34 of the trailing half are drawn by vacuum to the upper nose roll. The trailing side panels 34 are thus drawn to 20 the upper nose roll 218 and follow its rotation around the roll and over a side panel separation plates 230 (Figures 8 and 10). Similarly, as the leading half of the part 102 is pulled into the folding nip 204, compressed air can be shut off to the lower nose roll 219 so that the side panels 134 of the leading half are drawn by vacuum to the lower nose roll. The leading side panels 134 are thus drawn to the lower nose roll 219 and follow its 25 rotation around the roll and beneath the side panel separation plates 230.

Figure 10 illustrates a portion of a partially assembled training part 102 positioned between the upper and lower folding conveyors 206 and 208 at a location downstream of the nose rolls 218 and 219. At this point, the training part 102 has been folded in half and is being transported in the machine direction 108 by the conveyors 206 and 208. The 30 illustrated folding mechanism 202 can thus maintain the front side panels 34 separated from the back side panels 134 during folding.

Each folding conveyor 206 and 208 as illustrated in greater detail in Figure 10 can comprise a frame structure 210, a plurality of rotatable pulleys 211 associated with the frame structure, and a continuous belt 212 carried on the pulleys. A drive system and 35 conveyor shaft (not shown) can be used to rotatively drive one or more of the pulleys. The folding conveyors 206 and 208 can comprise vacuum conveyors as are well known in the

art, in which case the continuous belt can be formed of a fluid permeable material. The folding conveyors desirably transport the training pants 102 with the longitudinal center line of the training pants traveling on the longitudinal center line of the conveyors. As depicted, the front and back side panels 34 and 134 can project laterally outward from the frame structure 210, outstretched in the cross-machine direction.

5 While traveling on the folding conveyors 206 and 208, the side panels 34 and 134 can be smoothed out or straightened if desired by various means including fluid stabilizing devices (not shown in Figure 10). Suitable fluid stabilizing devices can comprise air knives, air bars, air nozzles, vacuum devices or the like to provide a stream of fluid directed toward the side panels. The fluid stabilizing devices can be incorporated within 10 either or both of the folding conveyors 206 and 208 or can comprise separate devices positioned in proximity to the conveyors.

As a result of the illustrated folding mechanism 202, the front waist region 22 and front side panels 34 of the partially assembled training pant 102 are disposed above the 15 back waist region 24 and back side panels 134. The first fastening component 83 is disposed on the inner surface 28 of the back side panel 134 and the second fastening component 85 is disposed on the outer surface 30 of the front side panel 34. The separation plates 230 can extend in the machine direction 108 to maintain separation between the front and back side panels 34 and 134. The separation plates 230 can 20 comprise a low friction material or coating, such as: stainless steel; teflon; aluminum; ultra-high molecular weight polyethylene (UHMW-PE); polyoxymethylene (acetals), for instance a homopolymer available from E. I. Du Pont de Nemours and Company, Wilmington, Delaware USA under the tradename DELRIN; or the like. In particular embodiments, the separation plates 230 can comprise a thin layer of teflon, UHMW-PE, 25 DELRIN or the like glued to a plate formed of steel, aluminum or the like. The separation plates can be mounted using suitable support members 232 (Figure 10) to either the folding conveyors 206 or 208 or other suitable frame structures (not shown).

From the folding station 200, the continuous stream of discrete, partially assembled and folded training pants 102 enters a seaming section 250, an embodiment 30 of which is shown in Figure 3. The seaming section 250 can encompass processes and apparatus for controlling the unattached side panels 34 and 134, guiding the side panels into an overlapping orientation to form a lap seam, and bonding the side panels together. In general, the process and apparatus can bend the front or back side panels 34 or 134 approximately 90 degrees using an air flow device (see Figure 14). After one pair of side 35 panels is oriented in this manner, a panel folding mechanism can fold the other pair of side panels so that they are positioned transversely outward from the first pair of side

panels (see Figure 18). The second pair of side panels can then be brought into contact with the first pair of side panels. In the embodiment shown in Figure 4, the side panels are refastenably bonded together using mating mechanical fastening components 82-85, although other refastenable or permanent bonding arrangements can also be used. The 5 seaming section 250 can thus convert the partially assembled and folded training pants 102 into prefastened training pants 20 each having a waist opening 50 and a pair of leg openings 52 (Figure 4). The illustrated seaming section 250 could of course be inverted so that the lower side panel is first folded upward to form the inner side panel of the lap seam (not shown). From the seaming section 250, the training pants 20 can be processed 10 through various finishing stations 254, for operations such as side panel tucking, packaging, or the like.

The partially assembled training pants 102 can be transported in the machine direction 108 through the seaming section 250 by a transport system, such as conveyors or other suitable means. In the illustrated embodiment, the training pants 102 are 15 transferred from the upper and lower folding conveyors 206 and 208 (Figures 2 and 8-10) to upper and lower alignment conveyors 256 and 258 (Figures 3 and 11-19). The alignment conveyors 256 and 258 transport the training pants 102 through an interior panel positioning station 260 (Figures 3 and 11) and an exterior panel positioning station 262 (Figures 3 and 15). Suitable conveyor mechanisms such as vacuum conveyors or 20 non-vacuum conveyors are available from various commercial vendors. Alternatively, the transport system can comprise any means to transport the folded products.

Formation of the side panel lap seam will be described in greater detail with reference to Figures 11-19. Figure 11 separately illustrates the interior panel positioning station 260 of the seaming section 250, where an interior panel positioning mechanism 261 positions one of the side panels 34 or 134 on each side of the training pant 102 to 25 form the interior side panel of the lap seam. Figures 12-14 illustrate section views of a training pant 102 at a series of continually advancing positions within the interior panel positioning station 260. Figure 15 separately illustrates the exterior panel positioning station 262 of the seaming section 250, where an exterior panel positioning mechanism 263 positions the other of the side panels 34 or 134 on each side of the training pant 102 30 to form the exterior side panel of the lap seam. In the illustrated embodiment, the front side panels 34 carrying the second fastening components 84 and 85 form the interior side panels of the lap seam, and the back side panels 134 carrying the first fastening components 82 and 83 form the exterior side panels of the lap seam. Figures 16-19 35 illustrate section views of a training pant 102 at a series of continually advancing positions within the exterior panel positioning station 262. The description will focus on the

formation of a lap seam and bonding the side panels 34 and 134 together on one side of the training pant 102, although it should be recognized that a lap seam can be formed on the other side of the training pant in a similar manner. The refastenable seams 88 can be formed simultaneously or sequentially on the right and left sides of the pant 102.

5 Figure 12 illustrates the training pant 102 positioned between the upper and lower alignment conveyors 256 and 258 at a location downstream of the location illustrated in Figure 10. Each alignment conveyor 256 and 258 as illustrated can comprise a frame structure 270, a plurality of rotatable pulleys 271 associated with the frame structure, and a continuous belt 272 carried on the pulleys. A drive system and conveyor shaft (not shown) can be used to rotatively drive one or more of the pulleys. The alignment conveyors 256 and 258 can comprise vacuum conveyors or other suitable transport devices.

10 At the location illustrated in Figure 12, the front side panel 34 is disposed on or in close proximity to an upper skid plate 275 and the back side panel 134 is disposed on or in close proximity to a lower skid plate 277. The skid plates support the side panels 34 and 134 and establish greater separation between the side panels for subsequent folding operations. The upper skid plate can maintain separation of the side panels. The front side panel 34 can be transitioned onto the upper skid plate 275 with a ramp section 279 of the separation plate 230, or by other suitable means. The upper skid plate 275 and the separation plate 230 can be rigidly bonded together or integrally formed. The upper skid plate 275 can be rigidly mounted on the upper alignment conveyor 256 or another suitable member by support members 232 such as brackets or the like. The lower skid plate 277 can be rigidly mounted on the lower alignment conveyor 258 or another suitable member by any suitable means. The skid plates can be formed of the same materials as the separation plates 230.

15 As illustrated in Figure 12, the front side panel 34 can also be supported in part by an interior support member 280. The interior support member 280 can comprise an integral portion of the upper skid plate 275, or comprise a separate member disposed on or bonded to the upper skid plate, such as by mechanical fasteners, welding, adhesives, or the like. As described in greater detail below, the interior support member 280 can 20 comprise a cap of an air knife used in positioning the front side panel 34.

25 One or both of the side panels 34 and 134 can be smoothed out or straightened if desired by various means including fluid stabilizing devices. As shown in Figure 12, for example, an air knife 284, air bar, air nozzle or the like can be mounted above the front side panel 34 to provide a stream of fluid generally in the direction of arrow 285 to 30 stabilize and/or straighten the front side panel. A fluid stabilizing device (not shown) can

also be mounted on the interior support member 280 to stabilize and/or straighten the back side panels 134. In an alternative embodiment, the folding conveyors 206 and 208 and/or the alignment conveyors 256 and 258 can incorporate fluid stabilizing devices consisting of fluid manifolds operatively connected to a high pressure fluid source to fluidly

5 shake the side panels. Suitable mechanisms for smoothing and straightening the side panels 34 and 134 are disclosed in U.S. Patent 5,046,272 issued September 10, 1991 to Vogt et al., which is incorporated herein by reference. The terms "air" and "fluid" are used interchangeably herein to refer to any gaseous substance, for example, air at ambient temperature. Where the specific application permits, the term "fluid" also includes any

10 liquid medium.

Figure 13 illustrates the training part 102 between the upper and lower alignment conveyors 256 and 258 at a location downstream of the location illustrated in Figure 12. In Figure 13, the back side panel 134 has been transferred from the lower skid plate 277 to a lower air knife 290. The lower air knife 290 can further control and guide the position of

15 the back side panel 134 in preparation for subsequent operations. At the location illustrated in Figure 13, the front side panel 34 can continue to reside on or in close proximity to the upper skid plate 275 and the interior support member 280.

The lower air knife 290 can comprise an air plenum 291 and a cap 292 attached to the plenum with suitable fasteners (not shown). The plenum 291 and the cap 292 can be spaced apart slightly to form a thin nozzle 294 therebetween. The plenum 291 can define an internal chamber 295 and channels (not shown) to operatively connect the internal chamber to the nozzle 294. The air knife 290 can also comprise a port (not shown) to connect the internal chamber 295 to a source of pressurized air (not shown). The port can be located at one end of the air knife or at one or more other locations along the length of

20 the air knife. The length dimension of the air knife 290 can be oriented generally parallel to the machine direction 108, with the nozzle 294 extending over substantially all of the length dimension. The air knife 290 can have any desired length dimension, such as about 0.1 to about 1 meter, for example about 0.6 to about 0.7 meter.

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As viewed in Figure 13, the nozzle 294 expels air toward the back side panel 134 and parallel to the plane formed at the interface between the plenum 291 and the cap 292. For purposes of the present application, the direction air is expelled from the nozzle 294 at the moment when the air knife is activated will be referred to as the nozzle flow direction. The nozzle flow direction is generally toward the upper left of Figure 13.

The lower air knife 290 can further comprise a surface 296 adjacent and extending

30 beyond the nozzle 294, which surface will be referred to herein as a Coanda surface. The Coanda surface 296 is the surface that the air from the nozzle 294 will follow under

normal operating conditions. In the illustrated embodiment, the Coanda surface 296 is formed by a portion of the outer surface of the plenum 291 that extends beyond the cap 292. In this particular application, the Coanda surface 296 is curved relative to the nozzle flow direction. Specifically, the illustrated Coanda surface 296 in cross section is generally parallel to the nozzle flow direction at the nozzle 294 and gradually curves away from the nozzle and cap 292 forming a 90 degree curved portion 298. Further from the nozzle 294, the 90 degree curved portion 298 is followed by a generally planar portion 300. For purposes of the present invention, the Coanda surface 296 will be said to have a terminal edge 301, beyond which air from the nozzle 294 diverges and loses velocity. In the 5 illustrated embodiment, the terminal edge 301 is a 90 degree edge of the outer surface of the air knife 290.

10 The Coanda surface 296 in cross section defines a curvature from the nozzle 294 to the terminal edge 301. The Coanda surface 296 can have a curvature of 0 to about 180 degrees, particularly from 0 to about 90 degrees, and more particularly about 90 degrees 15 or greater. The curvature of the Coanda surface 296 can also represent the angle that the resulting sheet of air bends from the nozzle flow direction. The Coanda surface 296 can employ a variety of configurations beyond those specifically illustrated herein, such as a plurality of smaller curved portions separated by generally planar portions; larger or smaller radius curved portions; a generally planar portion between the nozzle and the 20 initial curved portion; a completely curved surface; or the like. Moreover, the air knives described herein can employ integral or separate plena, caps and/or Coanda surfaces.

In operation, compressed air is delivered to the internal chamber 295 and expelled from the nozzle 294 in the form of a jet. Due to the nozzle configuration, the jet forms an air sheet that further entrains ambient air. Based on the Coanda effect, which is sometimes referred to as the wall-attachment principle, the presence of the Coanda 25 surface 296 creates a differential in pressure across the two sides of the air sheet causing the sheet to attach to and follow the curved Coanda surface. Once the back side panel 134 passes beyond the downstream end of the lower skid plate 277, the back side panel 134 is drawn toward the lower air knife 290 by the laminar flow of the air sheet over the 30 Coanda surface 296. The nozzle 294 is desirably but not necessarily located immediately beyond the downstream end of the lower skid plate 277. The air flow through the nozzle 294 can be adjusted to establish the desired position of the side panel 134. For the illustrated embodiment, the air flow need not draw the side panel 134 fully parallel to the generally planar portion 300.

35 The air knife 290 can be formed of stainless steel, aluminum, or other suitable materials. Typical operating ranges for the air supply source are about 1.4 to about

6.9 bars (20-100 pounds per square inch) with air consumption of about 37 to about 116 standard liters per minute (SLPM) (1.3-4.1 standard cubic feet per minute) per 25 millimeter length of nozzle. For example, the air supply pressure can be 2.8 bars (40 psi) with air consumption of about 57 SLPM (2 SCFM). The aperture of the nozzle 294
5 can be adjusted with shims to obtain the desired air velocity. In one particular embodiment, the nozzle 294 opening is about 0.05 millimeters (0.002 inch). As an alternative to a continuous nozzle opening, the nozzle can comprise a different configuration such as a large number of individual, closely spaced apertures. Suitable air knives are available from various commercial vendors, such as ITW Vortec, or EXAIR
10 Corporation, both of Cincinnati, Ohio U.S.A.

Figure 14 illustrates the training pant 102 between the upper and lower alignment conveyors 256 and 258 at a location downstream of the location illustrated in Figure 13. The back side panel 134 can remain in the position established previously by the lower air knife 290. With the side panels sufficiently separated, the front side panel 34 can be
15 inwardly folded to form the interior panel of the lap seam. As shown in Figure 14, the front side panel 34 has been transferred from the upper skid plate 275 into operative proximity with an upper air knife 310.

The upper air knife 310 can be constructed of the same materials and can operate in the same general manner as the lower air knife 290. The upper air knives 310 can be
20 mounted on opposite sides of the alignment conveyors 256 and 258 and hence on opposite sides of the machine center line at fixed locations in the machine direction. The upper air knives 310 can but need not necessarily be aligned generally parallel to the machine center line such that a nozzle flow direction is generally perpendicular to the machine direction. With additional reference to Figure 20 which shows an enlarged
25 section view of the upper air knife 310, the upper air knife 310 can comprise an air plenum 311 and a cap 312 attached to the plenum with suitable fasteners 370. The plenum 311 and the cap 312 can form a thin nozzle 314 therebetween. The plenum 311 can define an internal chamber 315 and channels 372 to operatively connect the internal chamber to the nozzle 314. A port (not shown) can connect the internal chamber 315 to a source of
30 pressurized air (not shown). The length dimension of the upper air knife 310 can be oriented in the machine direction 108, although rotated relative to the angular position of the lower air knife 290 such that the nozzle flow direction of the upper air knife is generally horizontal. The nozzle flow direction of the upper air knife 310 is toward the left-hand side of Figures 14 and 20. The upper air knife 310 can be mounted on the support members
35 232 in a cantilevered configuration, so that the side panels 34 and 134 can pass the

downstream end of the upper air knife after the fastening components 82-85 are engaged.

- The upper air knife 310 can comprise a Coanda surface 316 that is adjacent and extending beyond the nozzle 314. In the illustrated embodiment, the Coanda surface 316 is formed by a portion of the outer surface of the plenum 311 that extends beyond the cap 312. The Coanda surface 316 is curved relative to the nozzle flow direction. Specifically, the illustrated Coanda surface 316 in cross section is generally parallel to the nozzle flow direction at the nozzle 314, and gradually curves away from the nozzle and cap 312 forming a curved portion 318. Thereafter, the Coanda surface 316 can include a generally planar portion 319 followed by a terminal edge 322, which can be a 90 degree edge of the outer surface of the air knife beyond which air from the nozzle diverges. The curved portion 318 can have an angle from 0 to about 270 degrees, particularly from 0 to about 90 degrees, and more particularly about 90 degrees. The generally planar portion 319 can be less curved than the curved portion, and is desirably flat.
- The Coanda surface 316 in cross section defines a curvature from the nozzle 314 to the terminal edge 322 of greater than 0 degrees, for example from greater than 0 to about 270 degrees, particularly about 20 degrees or greater, more particularly about 30 degrees or greater, more particularly about 45 degrees or greater, more particularly about 60 degrees or greater, more particularly about 80 degrees or greater, more particularly about 90 degrees or greater, such as about 90 to about 270 degrees, more particularly about 135 degrees or greater, such as about 135 to about 225 degrees, and in particular embodiments about 180 degrees. The curvature of the Coanda surface 316 can also represent the angle that the resulting sheet of air bends from the nozzle flow direction. The Coanda surface 316 can employ a variety of configurations. In this particular embodiment, the cap 312 of the upper air knife 310 extends upstream beyond the nozzle 314 to form the interior support member 280 (Figures 12 and 13).

In operation, compressed air can be delivered to the internal chamber 315 and expelled from the nozzle 314. The resulting air jet forms an air sheet that further entrains ambient air and becomes attached to the Coanda surface 316 due to the Coanda effect. Once the front side panel 34 passes beyond the downstream end of the upper skid plate 275, the front side panel is drawn toward the upper air knife 310 by the laminar flow of the air sheet over the Coanda surface 316. A supplemental air nozzle can also be employed to ensure that the front side panel 34 is in close proximity to the air knife 310. Sufficient air can be supplied to the nozzle 314 so that the resulting air sheet follows the curvature of the Coanda surface through the curved portion 318 and the generally planar region 319. The air sheet dissipates beginning at the terminal edge 322. In this way, the air sheet

from the upper air knife 310 passes through an angle of about 90 degrees. The nozzle 314 is desirably but not necessarily located immediately beyond the downstream end of the upper skid plate 275. The upper air knife 310 can be operated at the same or different air flow rates as the lower air knife 290.

- 5 As best shown in Figure 14, the size and position of the upper air knife 310 can be selected so that the second fastening component 85 is centered on the generally planar portion 319 of the upper air knife, for example in a vertical orientation. This generally planar portion 319 can subsequently provide a flat surface for engagement of the fastening components 82-85. Thus, at this point in the process, the folded training pants 10 102 can be transported downstream in the machine direction 108 with the front side panels 34 curved downward to a flat and stable position around the upper air knives 310. Due to the air stream expelled by the upper air knives 310, the front side panels can be supported on a cushion of air provided on the surfaces 316 of the air knives. Desirably, the cushion of air minimizes drag and skewing of the side panels as they are transported 15 in the machine direction. Also at this point, the back side panels 134 can be positioned flat and outward from the machine center line at a slightly lower horizontal position than the absorbent chassis 32.

- 20 Use of the terms "vertical" and "horizontal" and variations thereof have their usual meaning, however, the present invention contemplates that vertical surfaces can be "generally vertically" disposed if desired and would thus be oriented between the true vertical position and about a 45 degree position relative to the true vertical position. The same interpretation for "generally horizontally" disposed means an orientation between the true horizontal and about a 45 degree position relative thereto. The terms "upper" and "lower" are provided for ease of understanding, and it should be recognized that the 25 spatial arrangement of the elements being described could be inverted or arranged in another manner.

- Figures 16-19 illustrate the training pant 102 between the upper and lower alignment conveyors 256 and 258 at a sequence of locations downstream of the location 30 illustrated in Figure 14. The locations illustrated in Figures 16-19 are within the exterior panel positioning station 262 (Figure 15), where the exterior panel positioning mechanism 263 guides the back side panel 134 into overlapping orientation with the front side panel 34. The exterior panel positioning mechanism 263 can comprise any suitable device for moving the back side panels 134 into the desired overlapping orientation, including but not limited to folding boards, folding skis, paddles, fingers, vacuum devices, air blasts, 35 mechanical devices with reciprocating motion such as tuckers, four-bar linkages, slide-crank mechanisms, or the like and combinations thereof. In the illustrated embodiment, as

the back side panel 134 is transported in the machine direction 108, a panel folding mechanism comprising a panel folding head 340 can be reciprocated into and out of the plane formed between the alignment conveyors 256 and 258 to intersect the path of travel of the back side panel 134 and move the back side panel into overlapping orientation with 5 the front side panel 34. In the illustrated embodiment, beginning with Figure 16, the panel folding head 340 moves vertically into contact with the back side panel 134. The panel folding head 340 can continue to move upward and push the back side panel 134 upward further.

In particular embodiments, the exterior panel positioning station 262 can include a 10 separator panel 330 (Figures 3 and 15-19) to protect the established shape and position of the front side panel 34 during positioning of the back side panel 134. The separator panel 330 can alternatively or additionally form a folding edge 332 (Figure 16) to facilitate positioning of the back side panel 134. The illustrated separator panel 330 comprises a body portion 334 and an elongated finger portion 336. The body portion 334 and finger 15 portion 336 can be connected near the upstream end of the separator panel 330, with the finger portion projecting downstream in a cantilevered orientation (Figure 15). A slot 338 is formed between the body portion 334 and the cantilevered finger portion 336.

The separator panel body portion 334 can be mounted to the upper alignment conveyor 256 or other suitable frame structure. The separator panel 330 can be spaced 20 outward from the upper alignment conveyor 256 at a transverse location generally corresponding to the location of the generally planar surface 319 of the upper air knife 310. With reference to Figures 17-19, the finger portion 336 can be positioned so that the first fastening components 82 and 83 will overlap and/or engage the second fastening components 84 and 85 when the back side panel 134 is folded over the finger portion. 25 The size of the slot 338 can be selected to allow room for the fastening components 82-85 to be engaged in the region formed by the slot.

The lower air knife 290 can be positioned or controlled so that air from the lower air knife nozzle 294 does not interfere with or deflect off the panel folding head 340 beginning at about the location illustrated in Figure 16. The plenum 291 of the lower air 30 knife 290 can be chamfered if necessary so as not to interfere with movement of the panel folding head 340. The front side panel 34 can remain in the position established previously by the upper air knife 310 during the sequence illustrated in Figures 16-19.

When the back side panel 134 overlaps the front side panel 34 as illustrated in Figure 18, a fastener engagement mechanism 342 can cause the first and second 35 fastening components 83 and 85 to engage one another. As illustrated in Figure 19, the fastener engagement mechanism 342 can comprise one or more air nozzles 343 that

fluidly blast (see arrows) the first fastening component 83 of the back side panel 134 into contact with the second fastening component 85 of the front side panel 34. Alternatively, the panel folding head 340 can function as the fastener engagement mechanism 342. For example, the panel folding head 340 can be positioned so that movement of the panel 5 folding head causes the first fastening component 83 to contact the second fastening component 85. In one embodiment, the panel folding head 340 can provide initial contact between the fastening components and the air nozzles 343 can provide more secure attachment of the fastening components. Alternatively, the fastener engagement mechanism 342 can comprise an air knife or air bar, rollers, vacuum wheels, magnets, a 10 funnel or disc folding device, a folding board, a blade on a shaft, an air cylinder, or the like. The side panels 34 and 134 can pass the downstream end of the upper air knife 310 and the separator panel finger portion 336 after the fastening components 82-85 are engaged.

The panel folding head 340 can comprise a cover 344 with the fastener 15 engagement mechanism 342 mounted within the cover. The cover 344 desirably can have a length measured in the machine direction 108 that is the same or slightly greater than the machine direction length of the back side panel 134, particularly adjacent the distal edges 68. The fastener engagement mechanism 342 can comprise a manifold block 346, an internal chamber 348, a plurality of air nozzles 343, a port for connecting the internal 20 chamber to a source of pressurized air (not shown), and channels (not shown) within the manifold block operatively connecting the internal chamber and the air nozzles. The cover 344 can define one or more apertures 350 for the air nozzles 343. In one particular embodiment, the fastener engagement mechanism 342 comprises five air nozzles 343 that expel air through a slot 350 in the cover 344. This configuration desirably allows the 25 entire first fastening component 83 to move in step-wise fashion into contact with the second fastening component 85. The cover 344 can be formed of any suitable material such as stainless steel, or the like.

The panel folding head 340 can be mounted on any suitable support structure 354. The support structure 354 can comprise a rigid connection, such as one or more brackets, 30 or a moveable connection that permits the panel folding head to be moved for access to the various components, such as a piston and cylinder combination, slideable brackets, or the like. With reference to Figures 15 and 21, the panel folding head 340 can be connected either directly or indirectly to any suitable drive mechanism 356 for moving the panel folding head so that the back side panel 134 overlaps the front side panel 34. The drive 35 mechanism 356 can comprise, for example, a four-bar linkage system as illustrated, including a pair of vertically-stacked rotatable discs 358 and 359, a connecting rod 360

rotatively mounted at single points 362 and 363 to each of the discs, rotational drive shafts 364 and 365, and a motor (not shown) for rotating the drive shafts and discs.

- The timing and rotation of the drive mechanism 356 can desirably be controlled to provide one complete cycle of the panel folding head 340 for each training pant 102. This creates repeatable points of contact between the back side panel 134 and the cover 344. As the training pant 102 travels in the machine direction 108 with the back side panel 134 outstretched, the top surface of the cover 344 makes uniform contact on the underside of the back side panel. Due to the orbital travel of the panel folding head 340, it can not only lift the back side panel, but can also carry it in the machine direction 108. The cover 344 can be coated, for example with an aluminum-manganese composite or the like, to provide a positive gripping surface on the back side panel 134 while the side panel is carried into overlapping alignment with the front side panel 34. The drive mechanism 356 can be configured so that, as the panel folding head achieves its maximum vertical position (Figures 18 and 19), the horizontal machine direction speed approximates the machine direction speed of the training pants 102. Other arrangements for panel folding are disclosed in U.S. Patent Application Serial No. unknown, filed on May 15, 2001 by L. C. Hietpas et al. and titled "Orbital Motion Device For Seaming Garments," which is incorporated herein by reference. Alternative drive mechanisms 356 can include a stepper motor, a lineshaft drive, or the like.
- An alternative configuration of an upper air knife 410 is illustrated in Figures 22 and 23. The location of Figures 22 and 23 within the interior panel positioning station corresponds to earlier Figures 14 and 17. The illustrated upper air knife 410 comprises a plenum 311 defining an internal chamber 315, a cap 312 attached to the plenum and defining a nozzle 314 therebetween, and a Coanda surface 316 that is adjacent and extending beyond the nozzle. The Coanda surface 316 is curved relative to the nozzle flow direction. Specifically, the illustrated Coanda surface 316 in cross section is generally parallel to the nozzle flow direction at the nozzle 314, and gradually curves away from the nozzle and cap 312 forming a first curved portion 318. Thereafter, the Coanda surface 316 includes a first generally planar portion 319, followed by a second curved portion 320, followed by a second generally planar portion 321. The Coanda surface 316 has a terminal edge 322, which can be a 90 degree edge of the outer surface of the air knife beyond which air from the nozzle diverges. The individual curved portions 318 and 320, can have angles from 0 to about 180 degrees, particularly from 0 to about 90 degrees, and more particularly about 90 degrees. The generally planar portions 319 and 321 are less curved than either of the curved portions, and are desirably flat surfaces.

- The Coanda surface 316 in cross section defines a curvature from the nozzle 314 to the terminal edge 322 of greater than 0 degrees, for example from greater than 0 to about 270 degrees, particularly about 20 degrees or greater, more particularly about 30 degrees or greater, more particularly about 45 degrees or greater, more particularly about 5 60 degrees or greater, more particularly about 80 degrees or greater, more particularly about 90 degrees or greater, such as about 90 to about 270 degrees, more particularly about 135 degrees or greater, such as about 135 to about 225 degrees, and in particular embodiments about 180 degrees. The Coanda surface 316 can employ a variety of configurations.
- 10 In this particular embodiment, the cap 312 can be constructed to have a C-shaped cross section including a first flange 324, a second flange 326 and an intermediate member 325 connecting the first and second flanges. The first flange 324 can be positioned in close proximity to the plenum 311 to define the nozzle 314 therebetween. The second flange 326 can be spaced from but positioned in close proximity to the plenum 311. For example, the second flange 326 can be spaced from the outer surface of the plenum 311 by from about 1 to about 10 millimeters, such as about 3.2 millimeters. Desirably, the second flange 326 can be positioned opposite the second generally planar portion 321 of the Coanda surface 316 to define therebetween an exhaust passage 328 for air. The intermediate member 325 can interconnect the first and second flanges 324 15 and 326 and define a plurality of apertures 329 which are open to and in fluid communication with the exhaust passage 328. These apertures 329 can be a variety of shapes and sizes which permit air to exhaust from the upper air knife 410. In one embodiment, the apertures 329 define a plurality of slots each having a length in the machine direction of about 5 centimeters. The flanges 324 and 326, and the intermediate member 325 if employed, can be integrally formed or can comprise separate structures 20 bonded together.
- 25

In operation, compressed air can be delivered to the internal chamber 315 and expelled from the nozzle 314. The resulting air jet forms an air sheet that further entrains ambient air and becomes attached to the Coanda surface 316. The front side panel is 30 drawn toward the upper air knife 410 by the laminar flow of the air sheet over the Coanda surface 316. A supplemental air nozzle can also be employed to ensure that the front side panel 34 is in close proximity to the air knife 410. Sufficient air can be supplied to the nozzle 314 so that the resulting air sheet follows the curvature of the Coanda surface through the first curved portion 318, the first generally planar region 319, and the second 35 curved portion 320. The air sheet enters the exhaust passage 328 and dissipates as it is directed through the apertures 329 and toward the composite structure 33 of the training

part 102. In this way, the air sheet from the upper air knife 410 passes through an angle of about 180 degrees and does not affect the position of the back side panel 134. The nozzle 314 is desirably but not necessarily located immediately beyond the downstream end of the upper skid plate 275. The upper air knife 410 can be operated at the same or 5 different air flow rates as the lower air knife 290.

With reference to Figure 23, the second flange 326 of the upper air knife 410 can define a folding edge 341. As the panel folding head 340 moves vertically into contact with the back side panel 134, the back side panel can contact folding edge 341 to facilitate panel folding.

- 10 It will be appreciated that details of the foregoing embodiments, given for purposes of illustration, are not to be construed as limiting the scope of this invention. Although only a few exemplary embodiments of this invention have been described in detail above, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and 15 advantages of this invention. For example, features described in relation to one embodiment may be incorporated into any other embodiment of the invention. Accordingly, all such modifications are intended to be included within the scope of this invention, which is defined in the following claims and all equivalents thereto. Further, it is recognized that many embodiments may be conceived that do not achieve all of the 20 advantages of some embodiments, particularly of the preferred embodiments, yet the absence of a particular advantage shall not be construed to necessarily mean that such an embodiment is outside the scope of the present invention.

CLAIMS:

We claim:

1. A method of folding a material, comprising:
transporting a material comprising a panel in a machine direction;
5 transporting the panel in operative proximity to an air knife, the air knife comprising a nozzle and a curved Coanda surface; and
expelling air from the nozzle such that the panel is folded over the curved Coanda surface as the material is transported in the machine direction.
- 10 2. The method of claim 1, wherein the panel comprises a refastenable fastening component.
- 15 3. The method of claim 1, wherein the panel is folded over the curved Coanda surface through an angle of about 45 or greater.
4. The method of claim 3, wherein the panel is folded over the curved Coanda surface through an angle of about 90 degrees or greater.
- 20 5. The method of claim 1, wherein air is expelled from the nozzle in a direction generally perpendicular to the machine direction.
6. The method of claim 1, wherein the curved Coanda surface comprises a generally planar portion and a curved portion between the nozzle and the generally planar portion.
- 25 7. The method of claim 6, wherein the panel is drawn to and overlays both the curved portion and the generally planar portion.
8. The method of claim 1, wherein the panel is discontinuous in the machine direction.
- 30 9. A method of forming a prefastened pant, comprising:
transporting a stream of discrete, partially assembled and folded pants in a machine direction, each pant comprising a first waist region with opposed first side panels and a second waist region with opposed second side panels;
transporting the first side panels in operative proximity to air knives, each air knife comprising a nozzle and a curved Coanda surface;
- 35

- expelling air from the nozzles such that the first side panels are folded over the curved Coanda surfaces;
- folding the second side panels into position transversely outward from the first side panels; and
- bonding the respective first and second side panels together.
- 5
10. The method of claim 9, wherein the respective first and second side panels are refastenably bonded together.
- 10 11. The method of claim 9, wherein the air knives are mounted in a cantilevered configuration and the bonded side panels are transported past downstream ends of the air knives.
12. The method of claim 9, wherein the panel is folded over the curved Coanda surface
- 15 through an angle of about 45 or greater.
13. The method of claim 12, wherein the panel is folded over the curved Coanda surface through an angle of about 90 degrees or greater.
- 20 14. The method of claim 9, wherein air is expelled from the nozzles in a direction generally perpendicular to the machine direction.
15. The method of claim 9, wherein the first side panels are maintained separate from the second side panels prior to folding the second pair of side panels.
- 25
16. A method of forming a prefastened pant, comprising:
- transporting a stream of discrete, partially assembled and folded pants in a machine direction, each pant comprising a first waist region with opposed first side panels and a second waist region with opposed second side panels, the first side panels
- 30 comprising first fastening components and the second side panels comprising second fastening components capable of refastenably engaging the first fastening components;
- transporting the first side panels in operative proximity to air knives, each air knife comprising a nozzle and a Coanda surface, the Coanda surface comprising a curved portion and a generally planar portion, the curved portion disposed between the nozzle
- 35 and the generally planar portion;

- expelling air from the nozzles such that the first side panels are folded over the curved portion with the first fastening components disposed on the generally planar portions;
- moving the second side panels into overlapping orientation with the first side
- 5 panels with the second fastening components positioned transversely outward from the first fastening components; and
- refastenably engaging the first and second fastening components.
17. The method of claim 16, wherein the air knives are mounted in a cantilevered configuration and the refastenably engaged side panels are transported past downstream ends of the air knives.
- 10
18. The method of claim 16, wherein moving the second side panels comprises reciprocating a panel folding head to intersect a path of travel of the second side panels.
- 15
19. The method of claim 16, further comprising transporting the second side panels in operative proximity to other air knives each comprising a nozzle and a Coanda surface, and expelling air from the nozzles of the other air knives.
20. An exhausted air knife, comprising:
- a plenum defining an internal chamber, a nozzle operatively connected to the internal chamber, and a Coanda surface adjacent and extending beyond the nozzle, the nozzle defining a nozzle flow direction, the Coanda surface being curved in cross section relative to the nozzle flow direction, the Coanda surface defining a curvature of about 90 degrees or greater from the nozzle to a terminal edge, the Coanda surface comprising first and second curved portions and first and second generally planar portions, the first curved portion disposed between the nozzle and the first generally planar portion and the second curved portion disposed between the first and second generally planar portions;
- 25 and
- a flange positioned in close proximity to the Coanda surface opposite the second generally planar portion and defining therebetween an exhaust passage.
- 30
21. The exhausted air knife of claim 20, wherein the curvature is about 90 to about 270 degrees.

22. The exhausted air knife of claim 21, wherein the curvature is about 135 to about 225 degrees.
23. The exhausted air knife of claim 20, wherein the first and second curved portions each define angles of about 90 degrees or more.
24. The exhausted air knife of claim 20, further comprising a separate cap attached to the plenum and defining the nozzle therebetween.
- 10 25. An exhausted air knife, comprising:
 - a plenum defining an internal chamber;
 - a cap attached to the plenum, the cap comprising a first flange, a second flange and an intermediate member connecting the first and second flanges, the first flange positioned in close proximity to the plenum and defining therebetween a nozzle that is in fluid communication with the internal chamber, the nozzle defining a flow direction, the second flange spaced from the plenum and defining therebetween an exhaust passage, the intermediate member defining at least one aperture in fluid communication with the exhaust passage; and
 - a Coanda surface adjacent and extending beyond the nozzle, the Coanda surface being curved in cross section relative to the nozzle flow direction, the Coanda surface defining a curvature of about 90 degrees or greater from the nozzle to a terminal edge.
- 20 26. The exhausted air knife of claim 25, wherein the Coanda surface comprises first and second curved portions and a generally planar portion disposed between the first and second curved portions.
- 25 27. The exhausted air knife of claim 26, wherein the first and second curved portions each define angles of about 90 degrees.
- 30 28. The exhausted air knife of claim 26, wherein the Coanda surface comprises a second generally planar portion and the second flange is positioned opposite the second generally planar portion.
- 35 29. The exhausted air knife of claim 25, wherein the second flange is spaced from the plenum by from about 1 to about 10 millimeters.

30. The exhausted air knife of claim 25, wherein the Coanda surface defines a curvature from the nozzle to the terminal edge of about 90 degrees to about 270 degrees.
31. The exhausted air knife of claim 30, wherein the Coanda surface defines a curvature from the nozzle to the terminal edge of about 135 to about 225 degrees.
5
32. An apparatus for folding a pair of garment side panels, comprising:
a transport system defining a machine direction and a machine center line; and
a pair of air knives located on opposite sides of the machine center line at fixed
10 locations in the machine direction, each air knife comprising a nozzle and a curved
Coanda surface, each air knife aligned generally parallel to the machine center line such
that a nozzle flow direction is generally perpendicular to the machine direction.
33. The apparatus of claim 32, wherein each curved Coanda surface comprises a
generally planar portion and a curved portion between the nozzle and the generally planar
15 portion.
34. The apparatus of claim 33, wherein each curved portion defines an angle of about
90 degrees or greater.
20
35. The apparatus of claim 32, wherein each Coanda surface defines a curvature from
the nozzle to a terminal edge of about 90 degrees to about 270 degrees.
36. The apparatus of claim 35, wherein each Coanda surface defines a curvature from
25 the nozzle to the terminal edge of about 135 to about 225 degrees.
37. An apparatus for positioning pairs of garment side panels in an overlapping
orientation, comprising:
a transport system defining a machine direction;
30 an interior panel positioning mechanism adapted to fold a first pair of side panels
about an axis generally parallel to the machine direction, the interior panel positioning
mechanism comprising air knives each comprising a nozzle and a curved Coanda
surface; and
an exterior panel positioning mechanism adapted to position a second pair of side
35 panels transversely outward from the first pair of side panels.

38. The apparatus of claim 37, wherein the nozzle defines a nozzle flow direction that is generally perpendicular to the machine direction.
39. The apparatus of claim 37, wherein the air knives are fixedly mounted in a cantilevered configuration relative to the transport system.
40. The apparatus of claim 37, further comprising separator panels mounted in proximity to the air knives, the separator panels comprising elongated finger portions.
- 10 41. The apparatus of claim 40, wherein the finger portions project downstream in a cantilevered orientation.
42. The apparatus of claim 40, wherein the finger portions define folding edges.

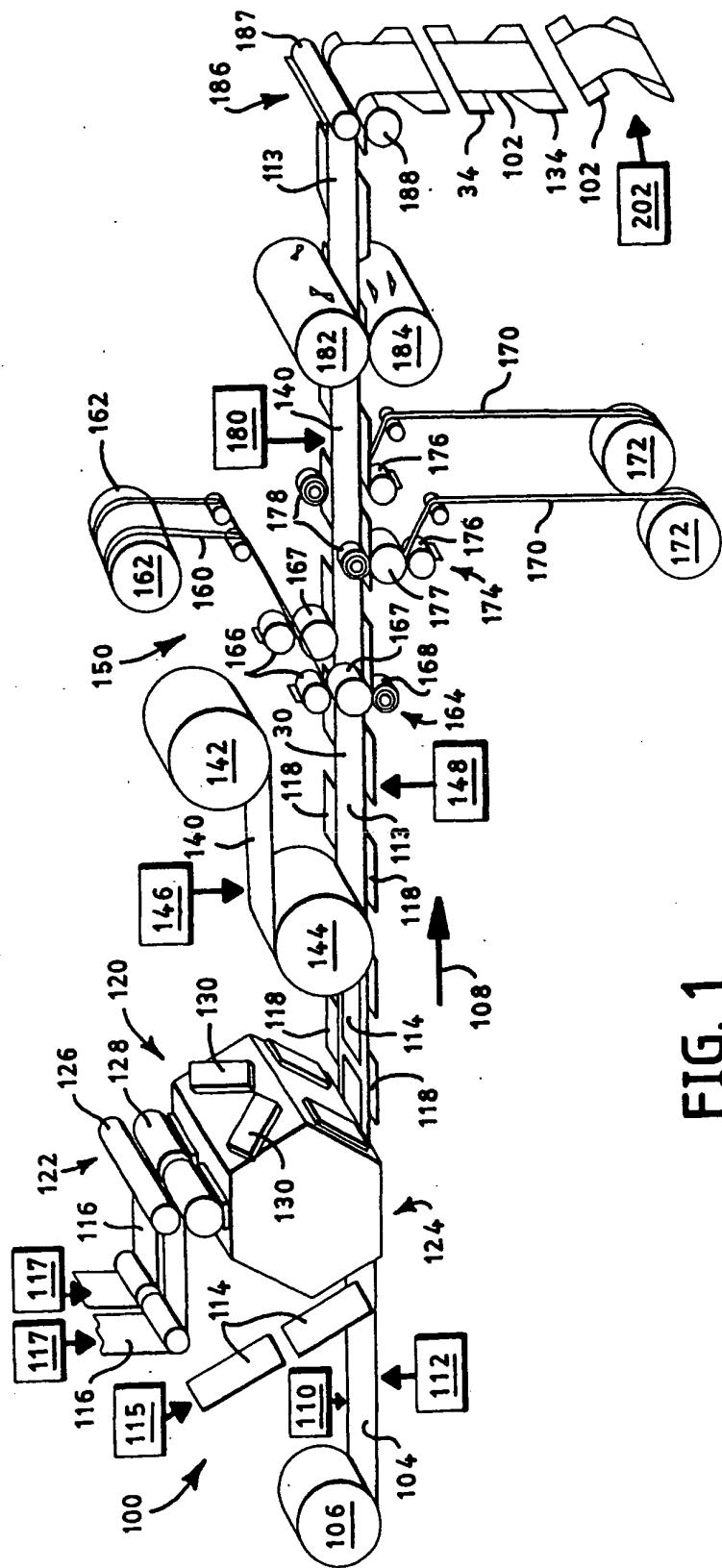


FIG. 1

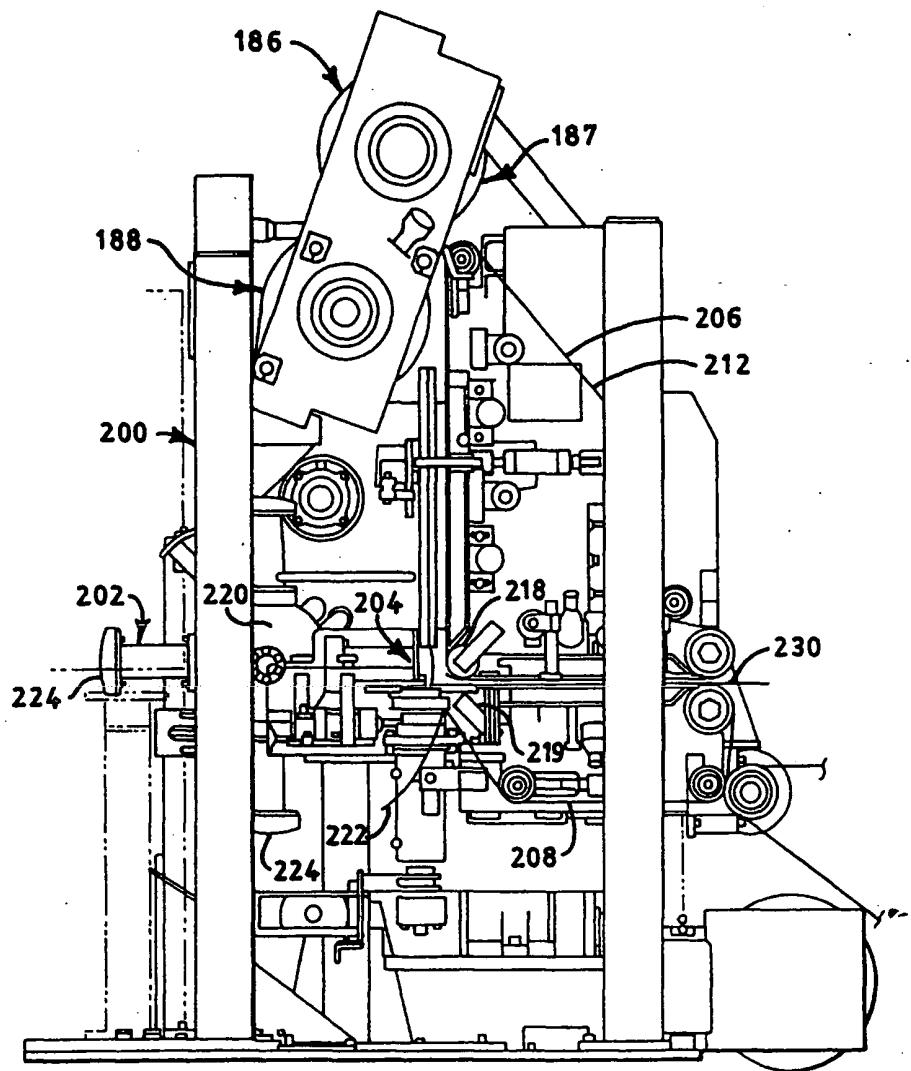


FIG. 2

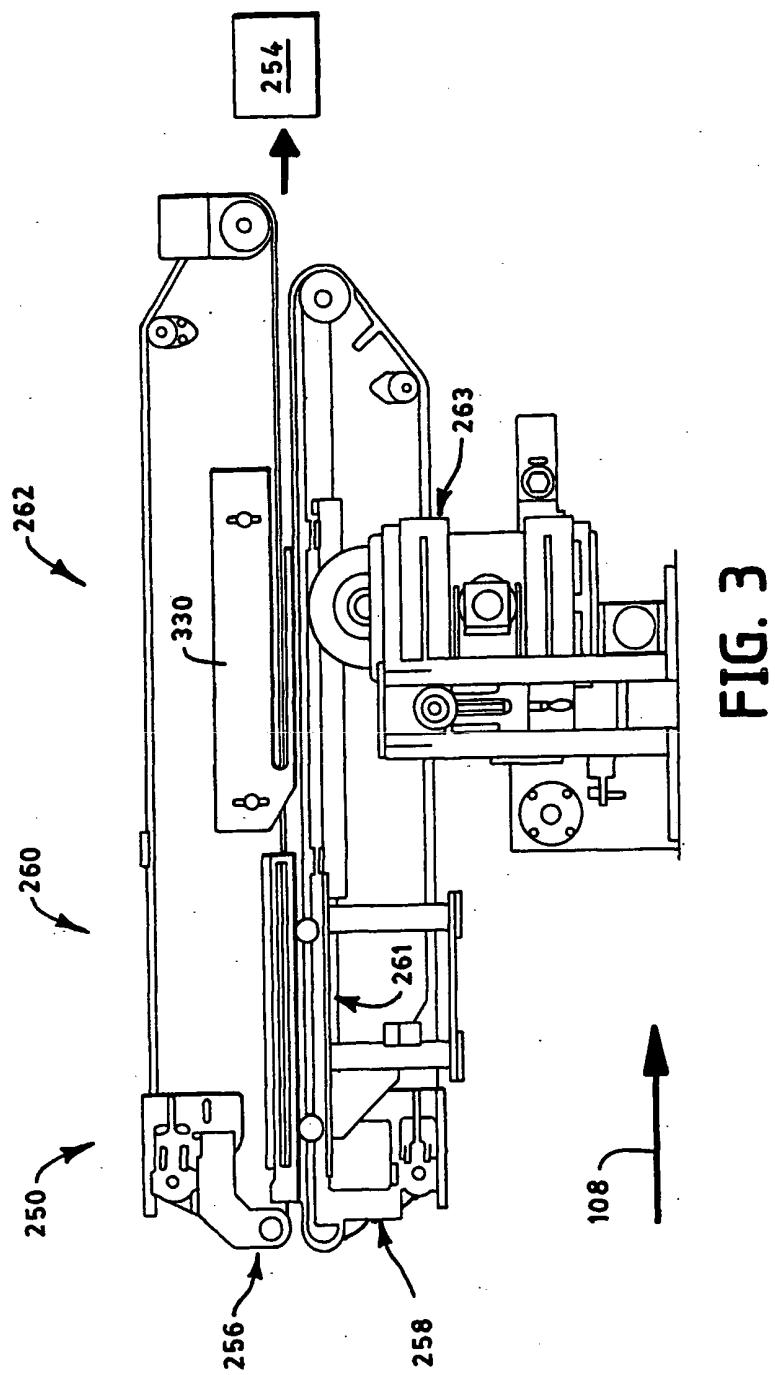


FIG. 3

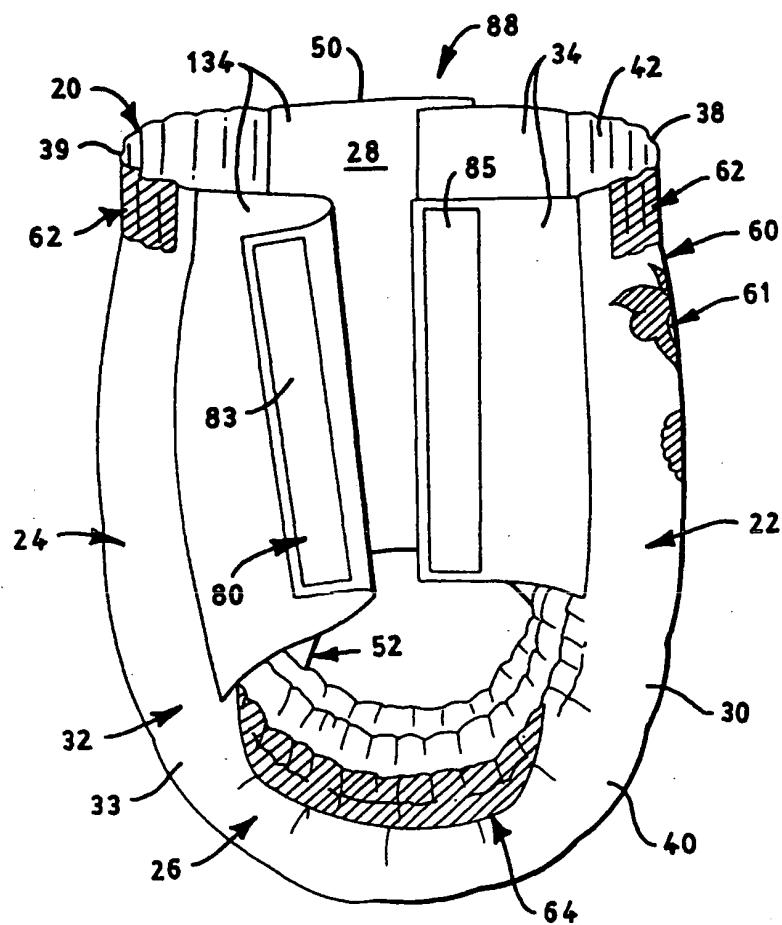


FIG. 4

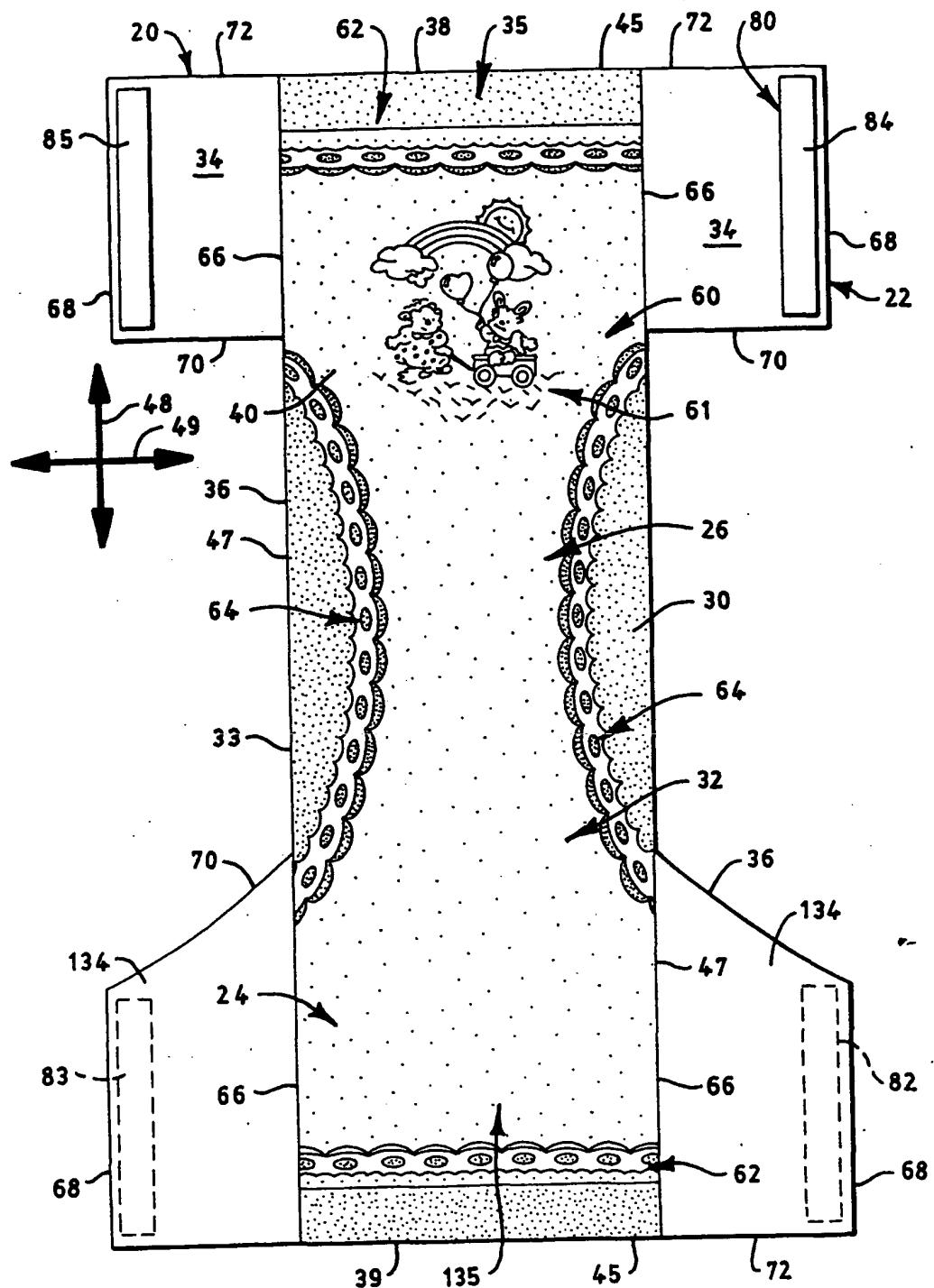


FIG. 5

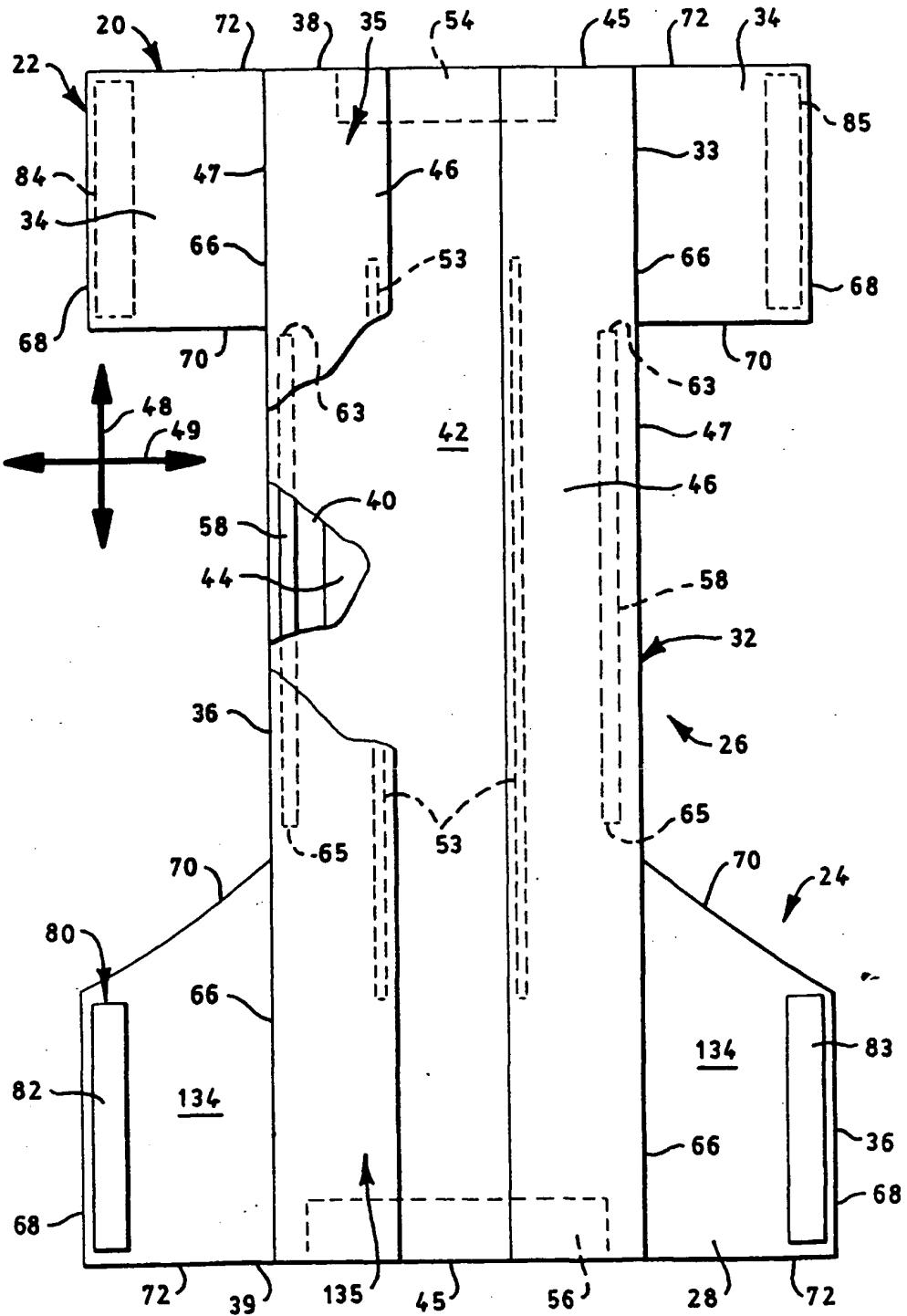


FIG. 6

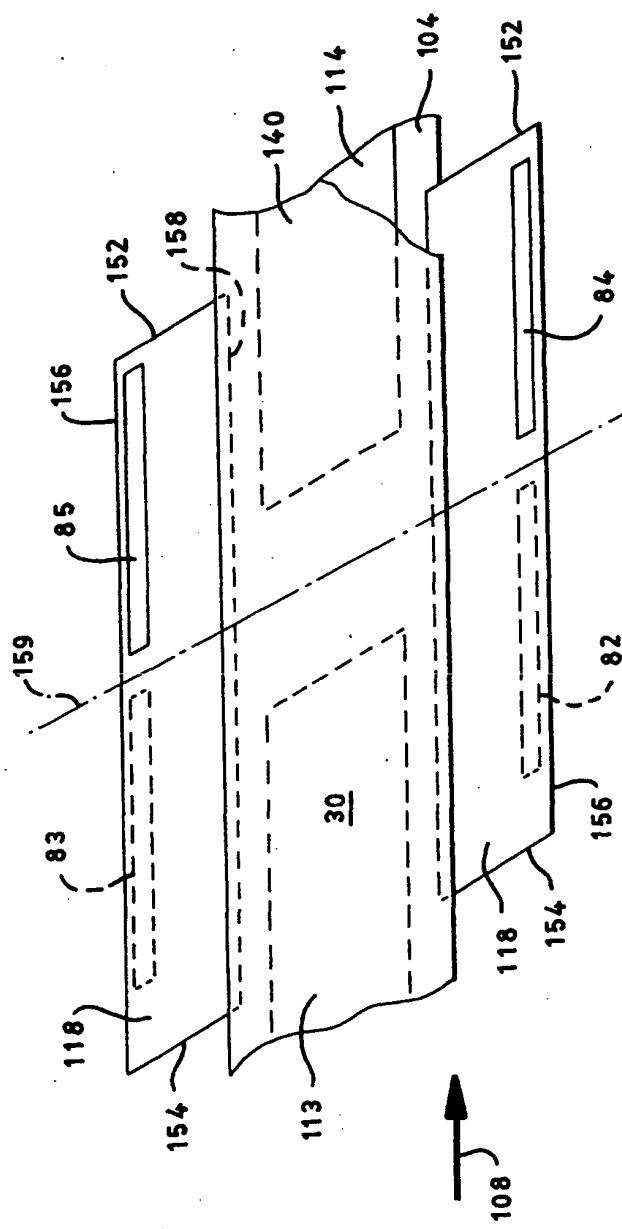
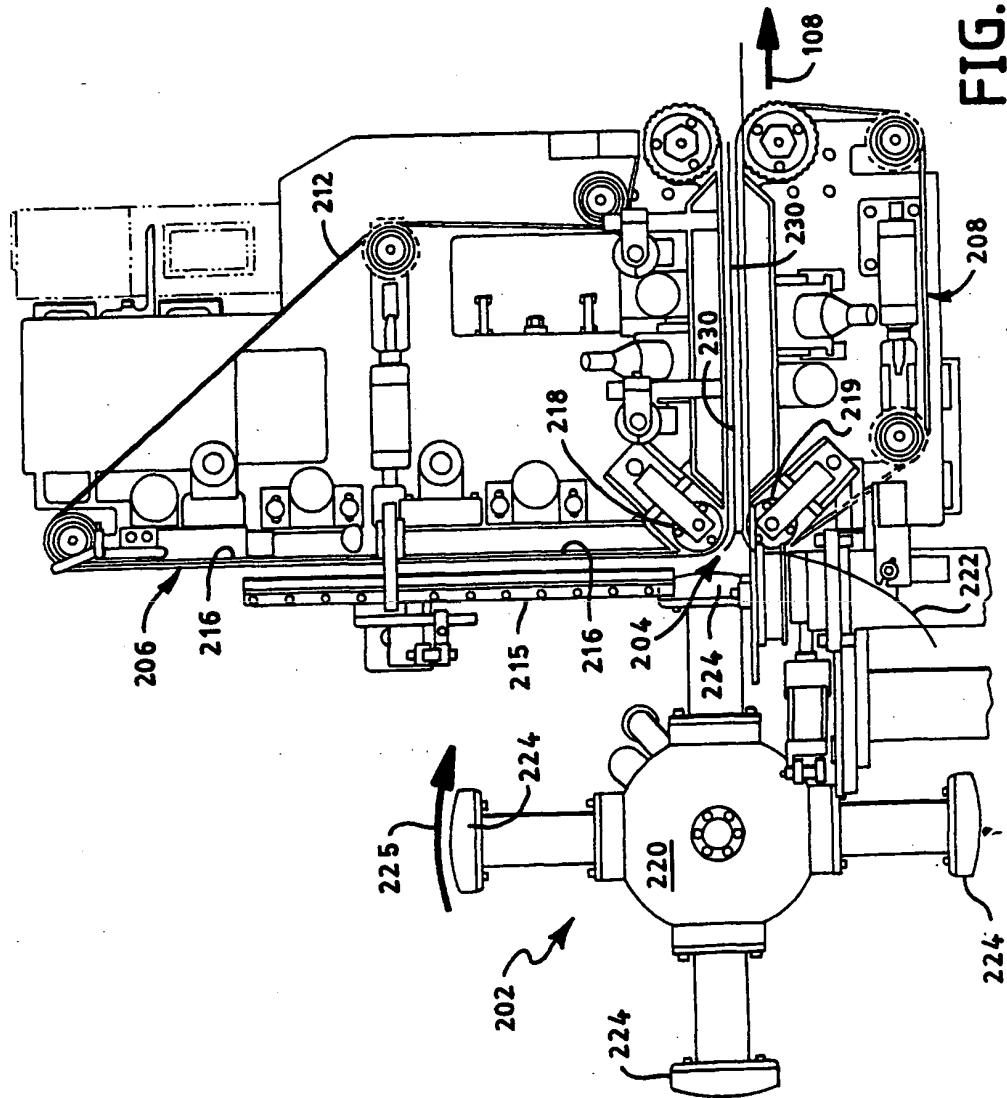


FIG. 7

FIG. 8



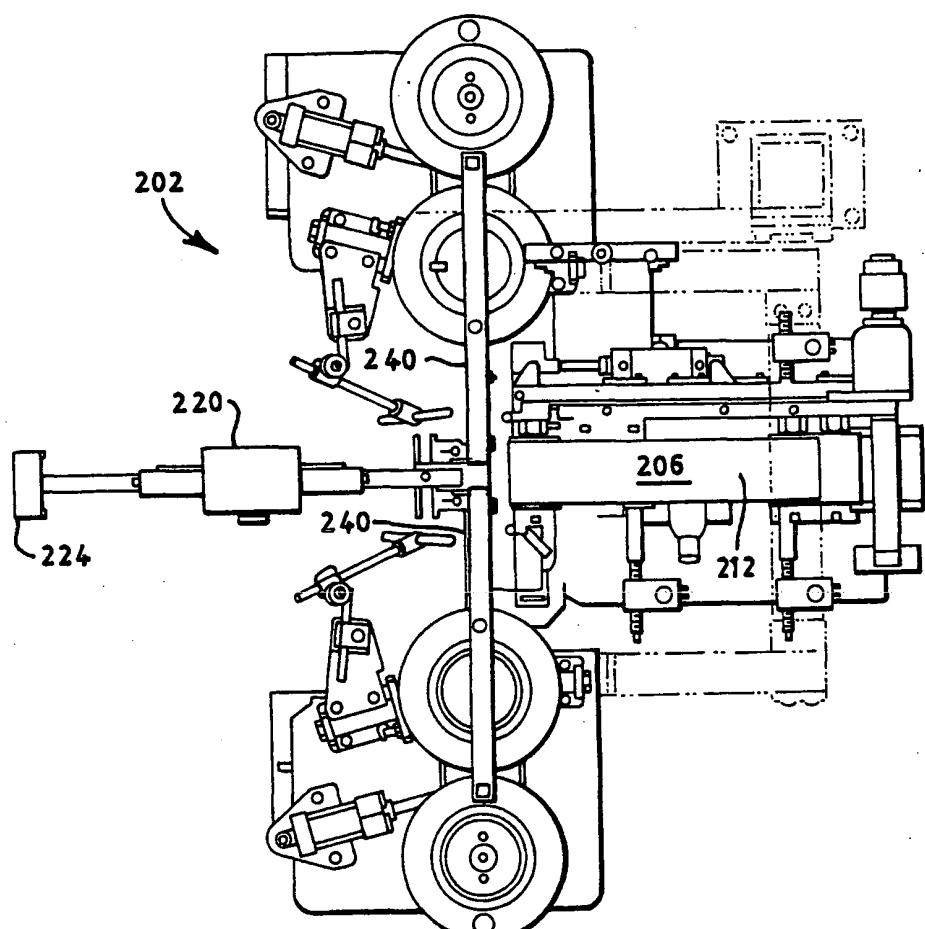


FIG. 9

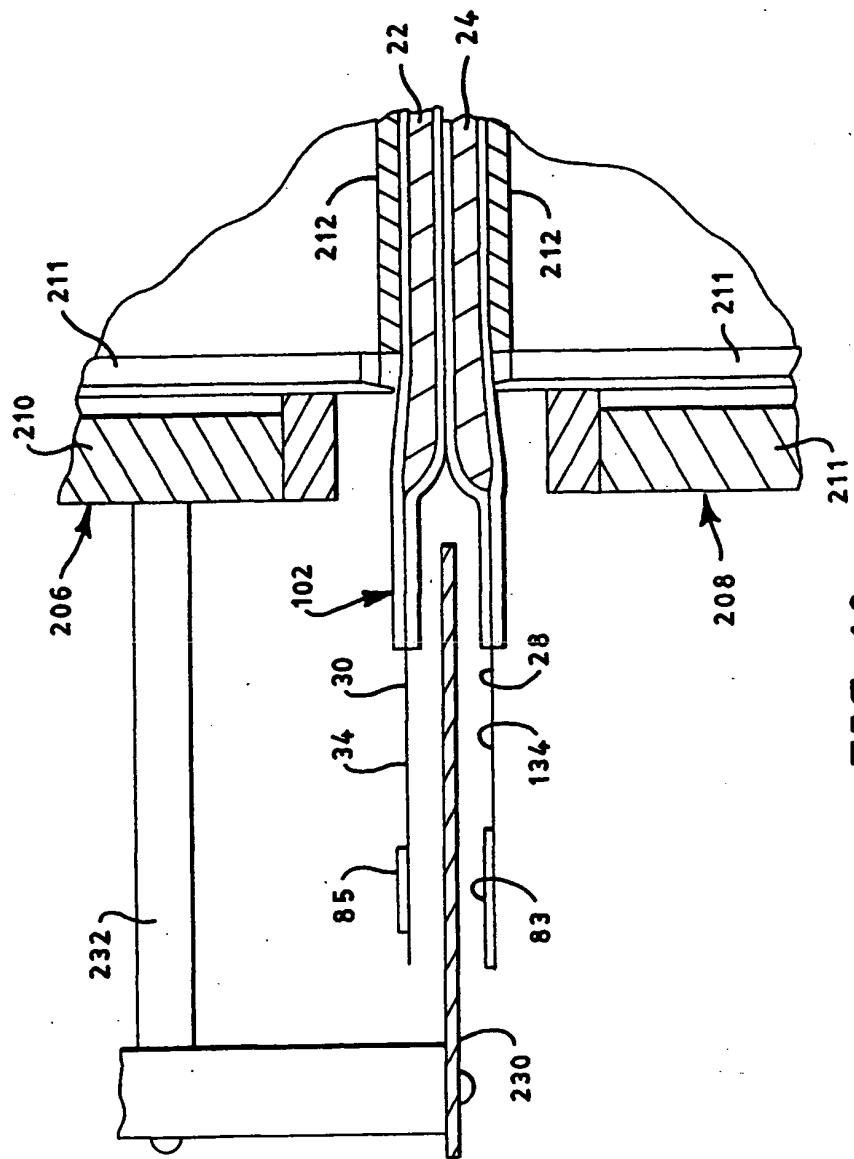


FIG. 10

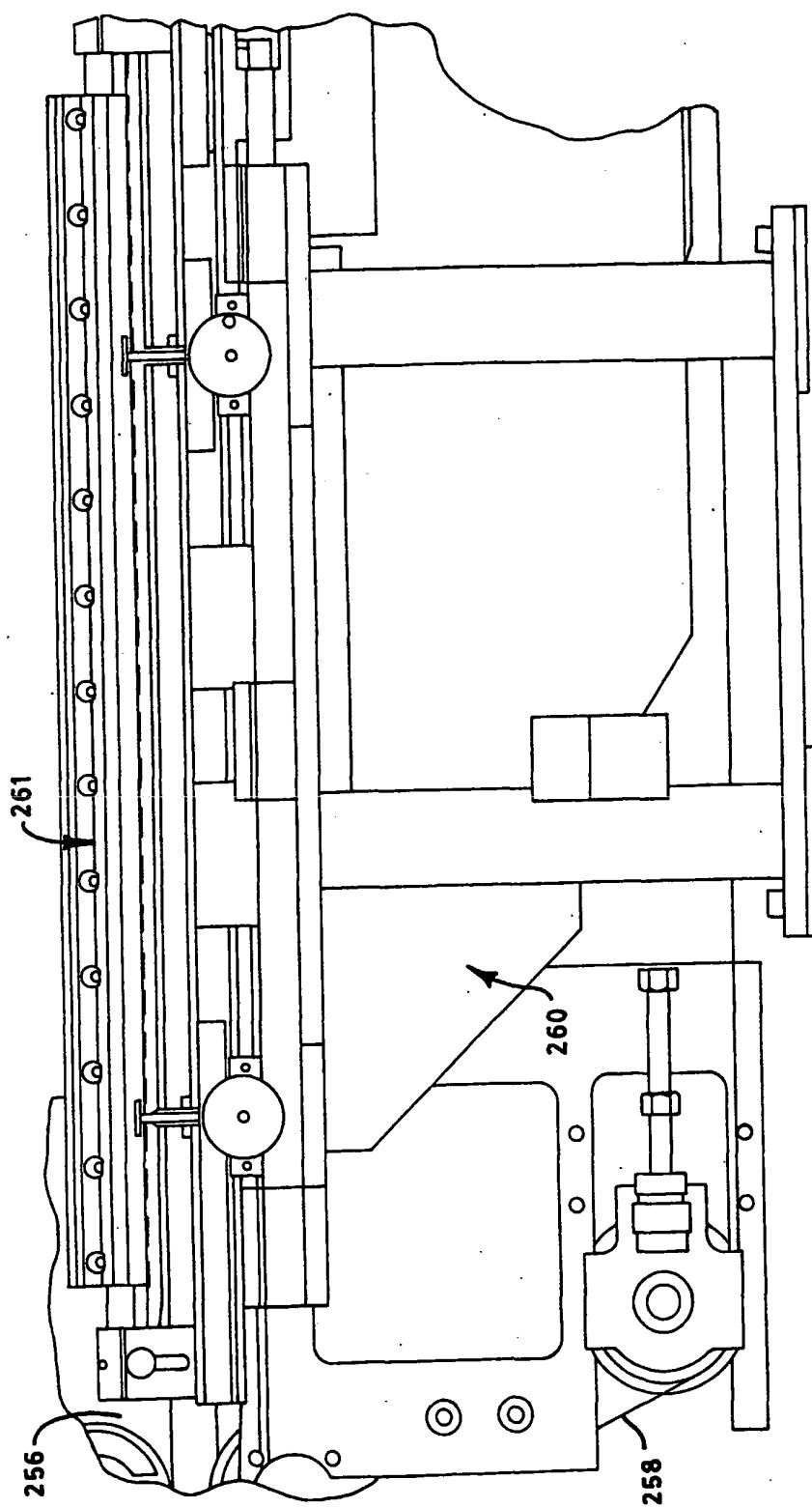


FIG. 11

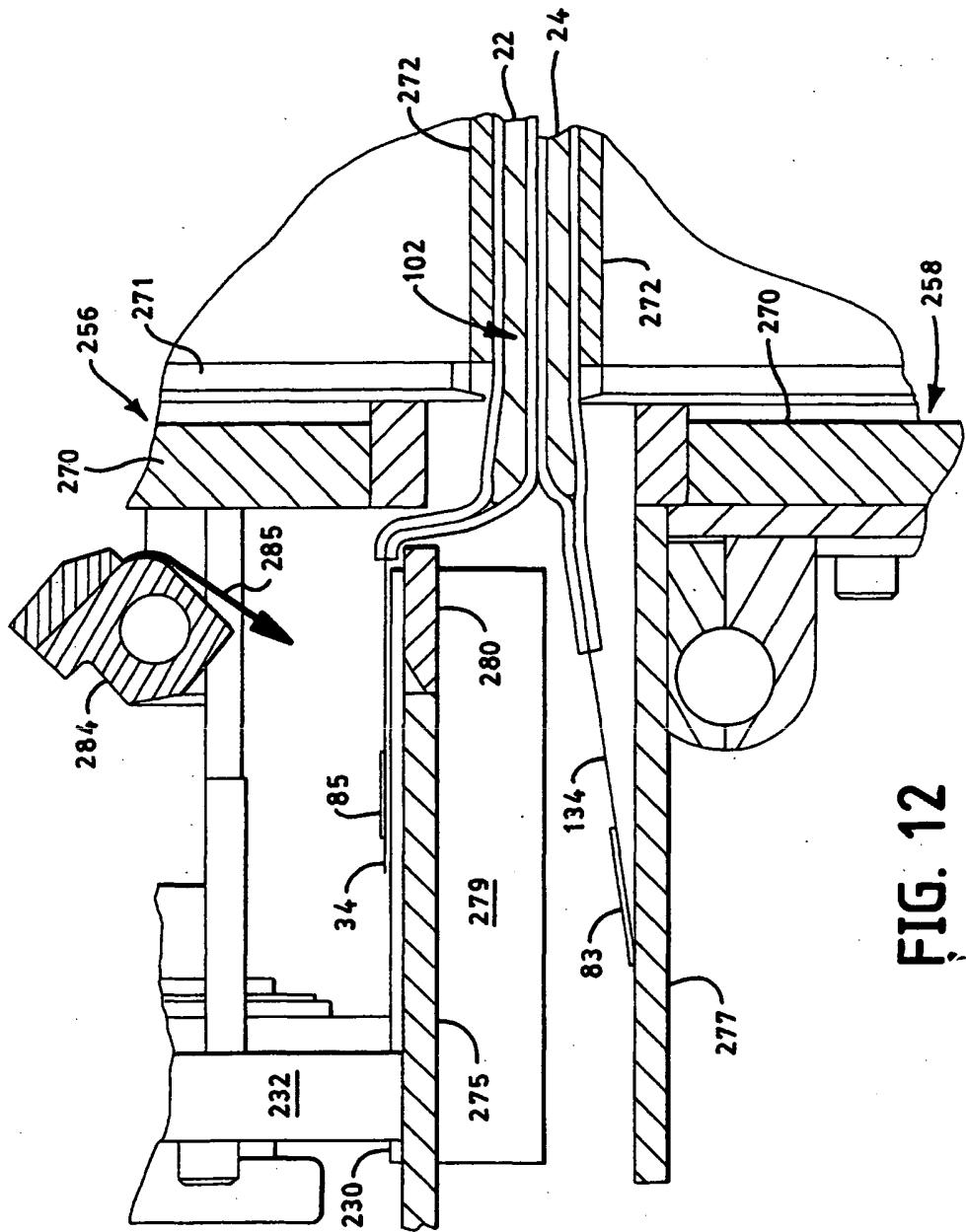


FIG. 12

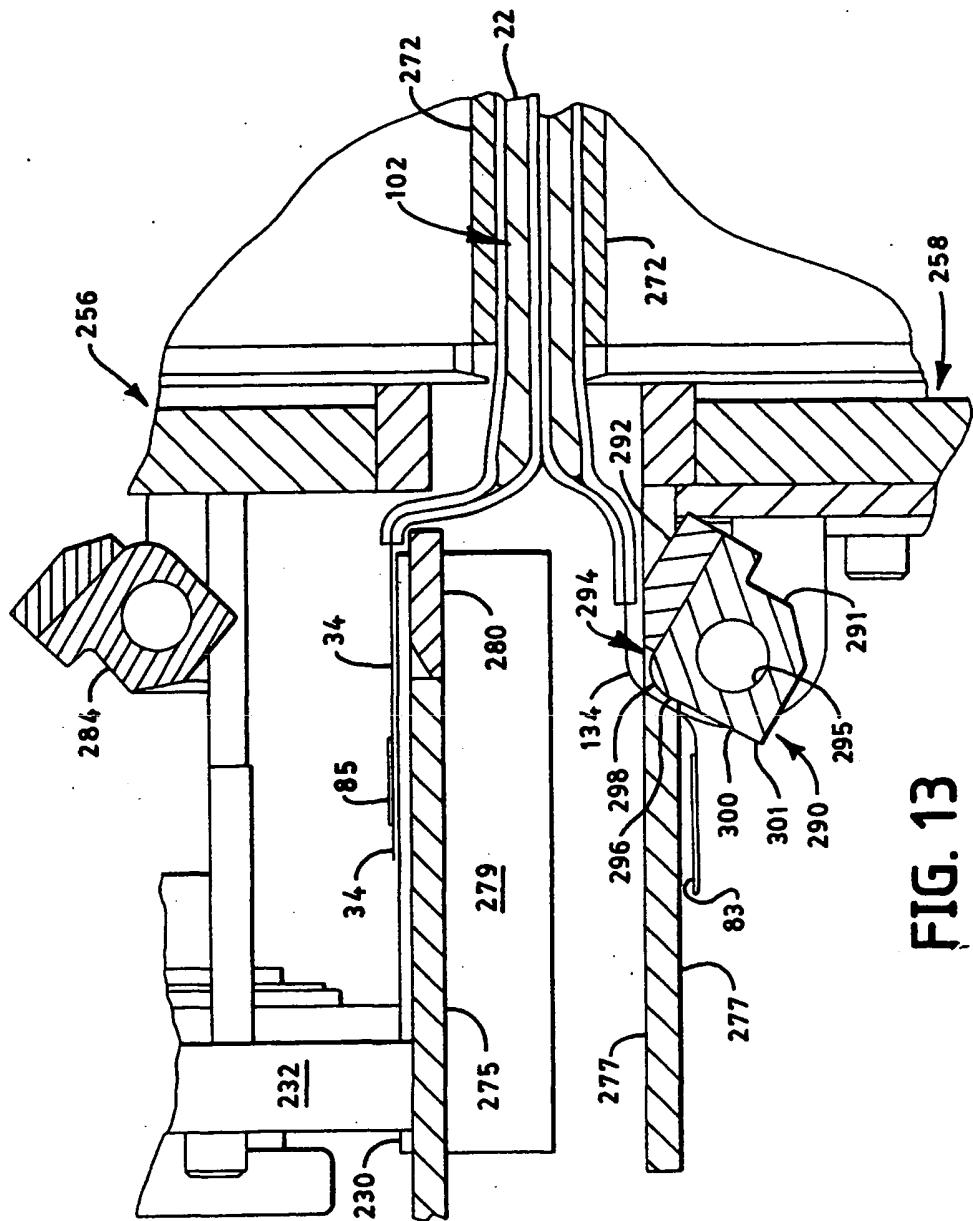


FIG. 13

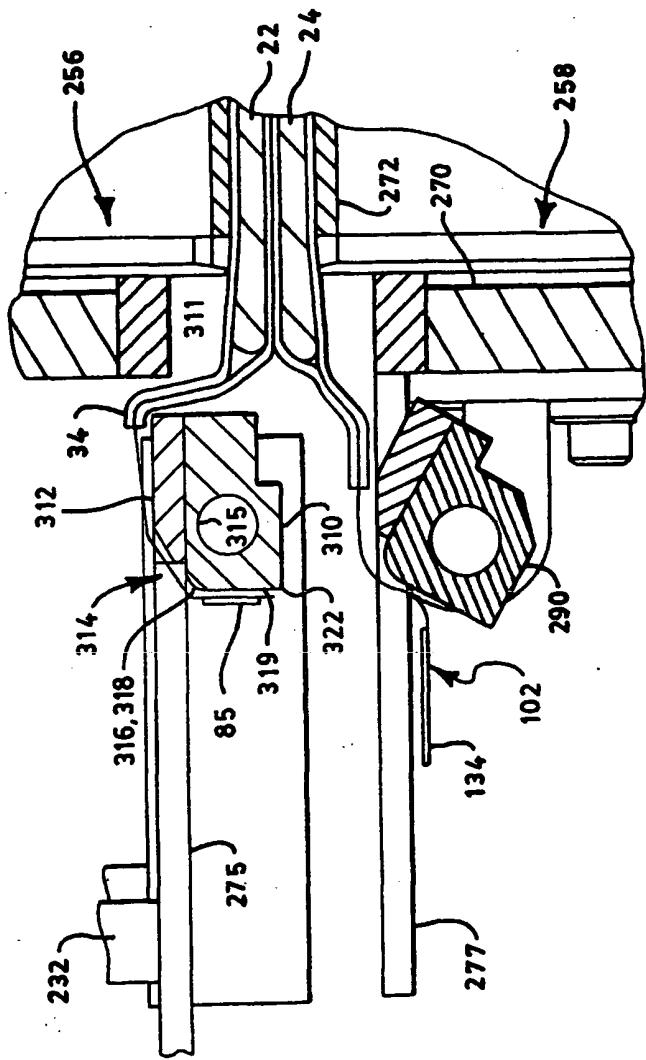


FIG. 14

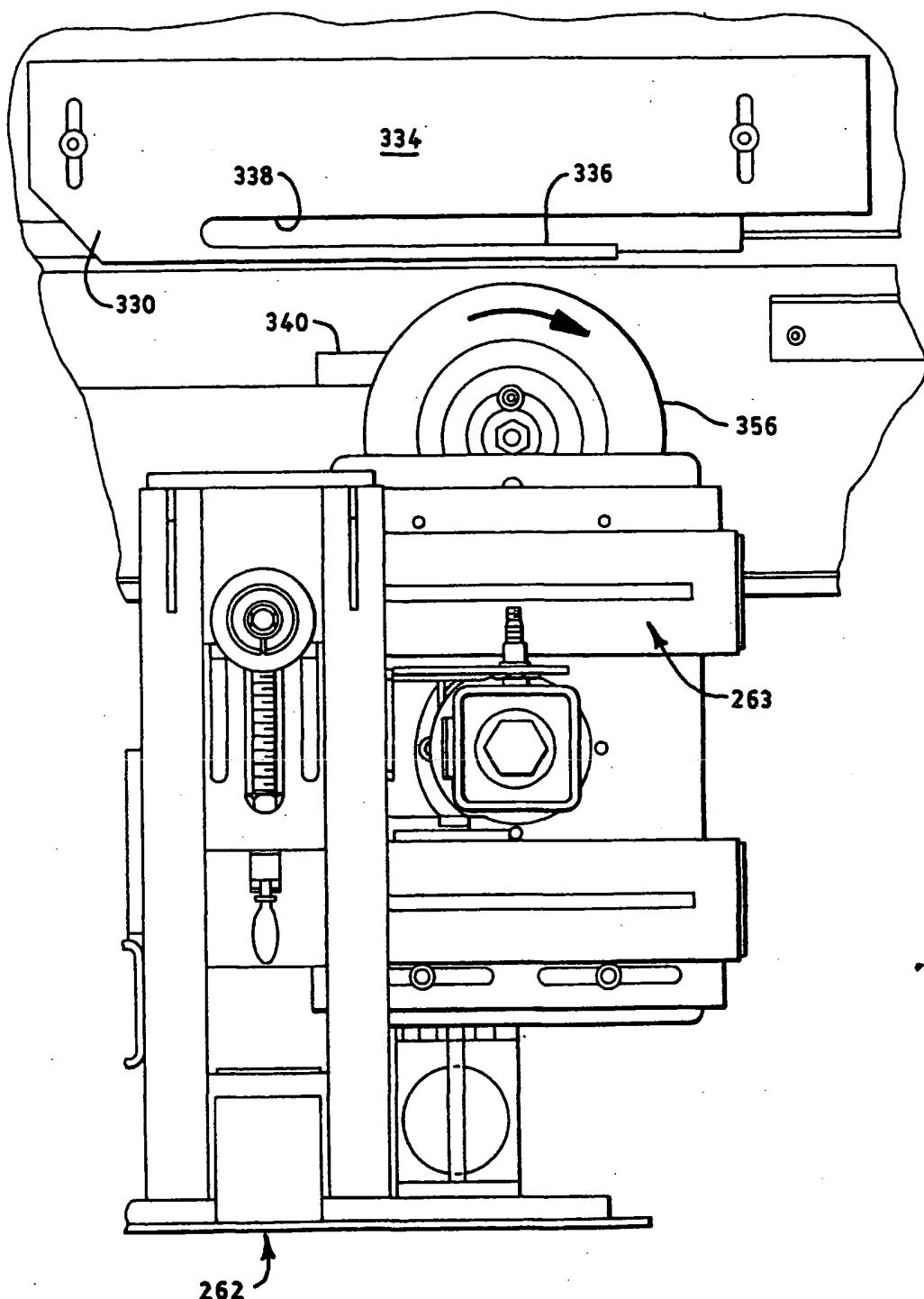


FIG. 15

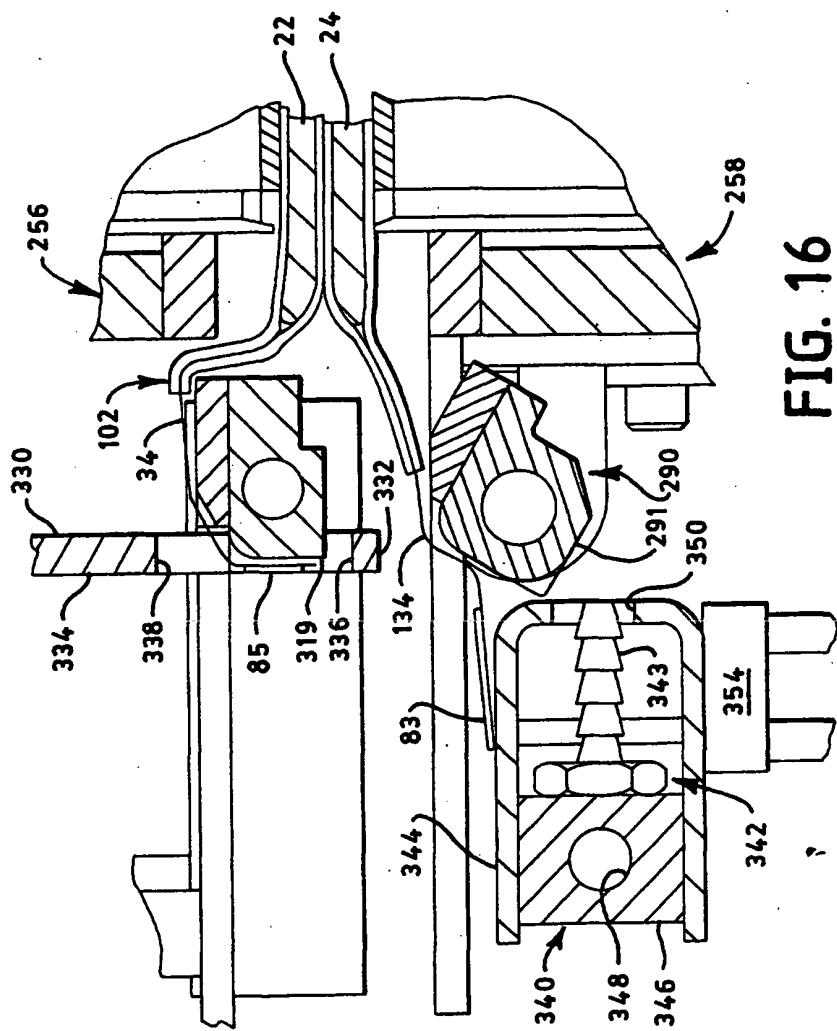


FIG. 16

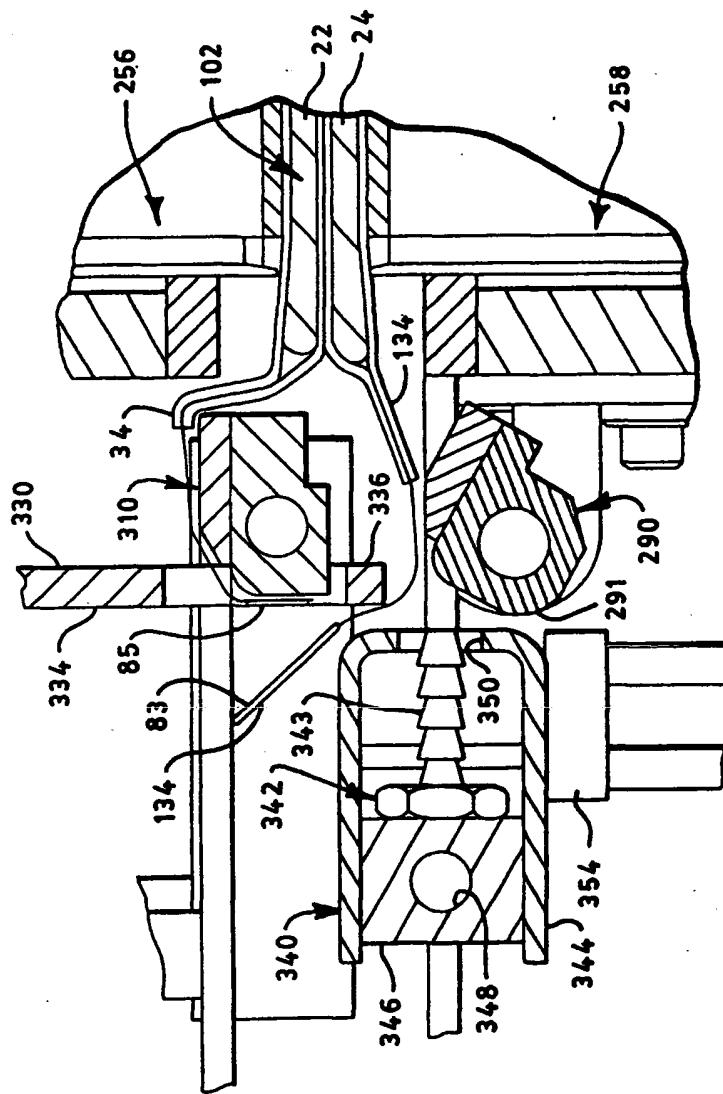


FIG. 17

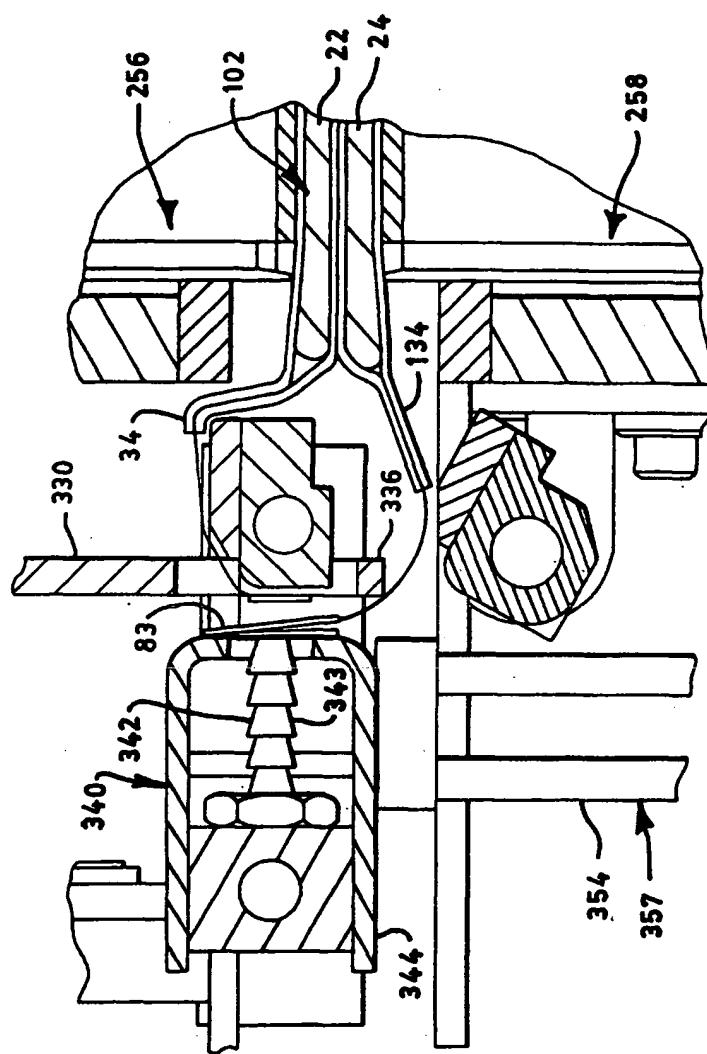


FIG. 18

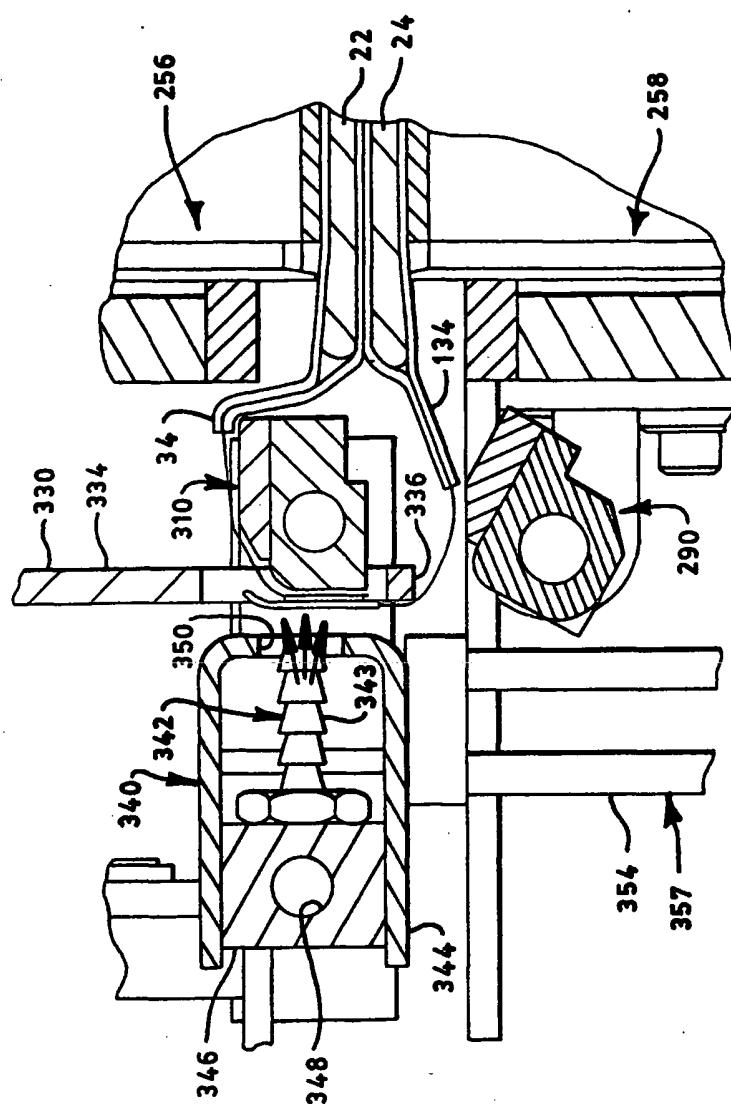


FIG. 19

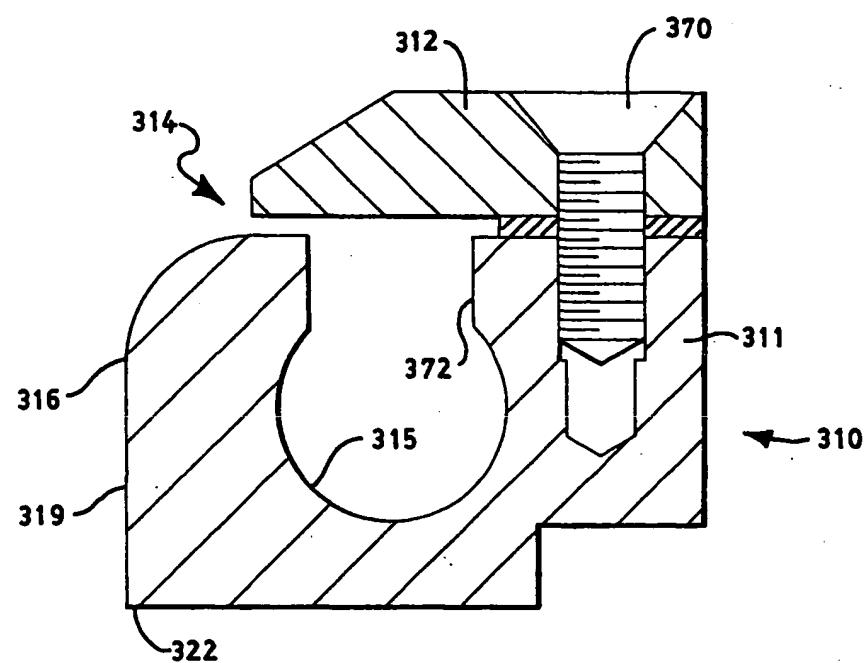


FIG. 20

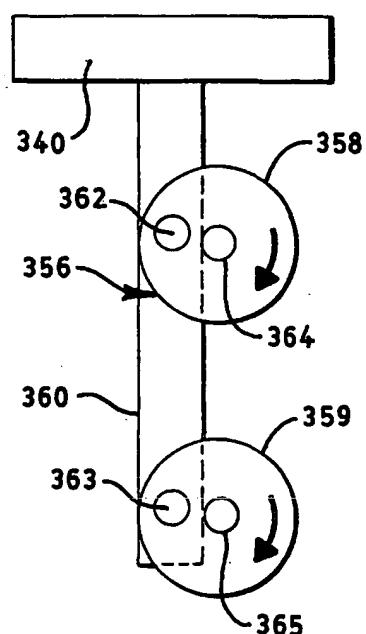


FIG. 21

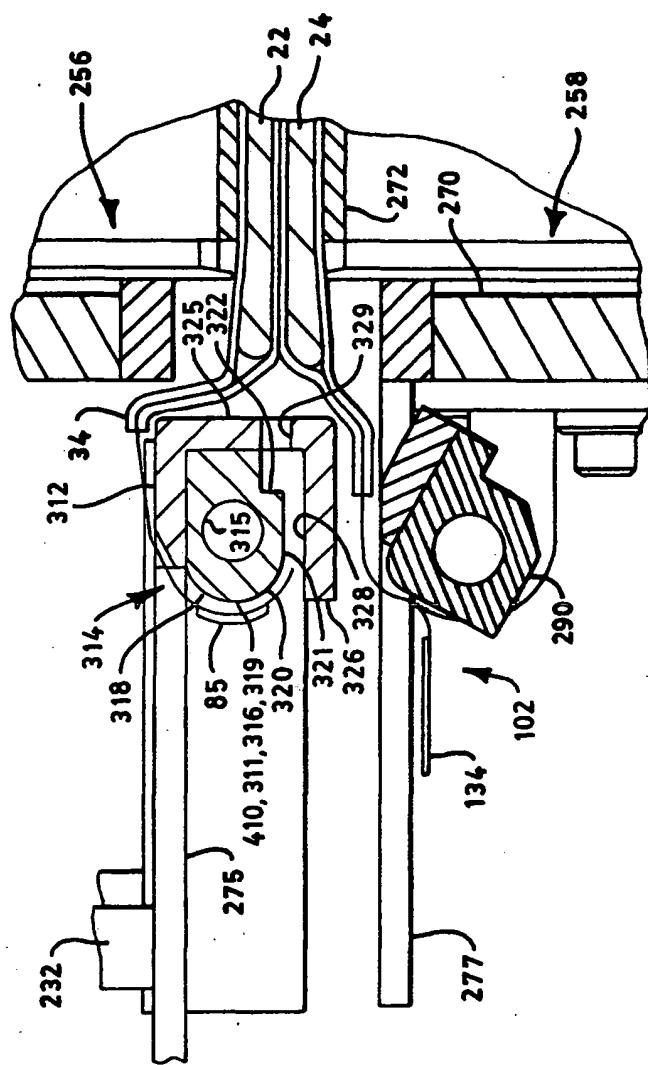


FIG. 22

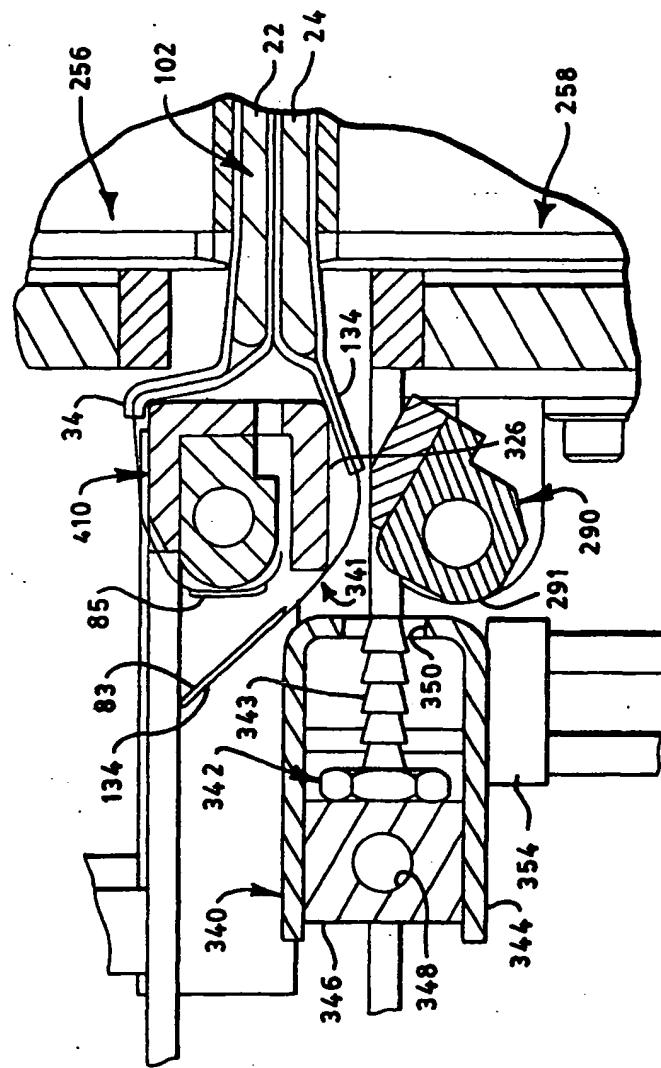


FIG. 23